Giga-tronics

Operating and Maintenance Manual

8500A Series

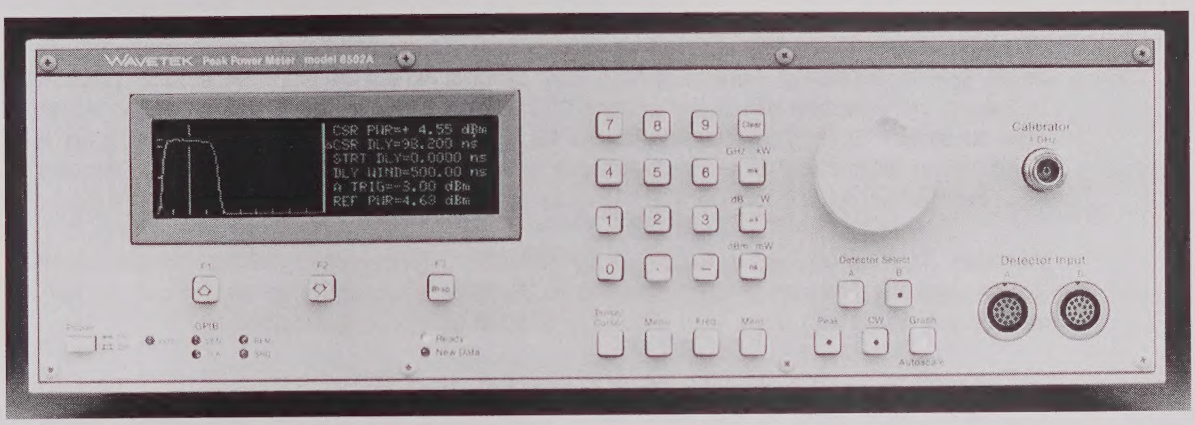
Peak Power Meters

PLEASE NOTE

As of 5/22/92 the Microwave Division of the Wavetek Corporation was acquired by the Giga-tronics Corporation and will now be called "Giga-tronics Power Measurements Division". Wherever the name "Wavetek" appears in this publication, please substitute "Giga-tronics" and adjust any records you may have pertaining to "Wavetek" to reflect this change.

Thank You

OPERATING AND MAINTENANCE MANUAL


WAVETEK Peak Power Meter model 8502A
CSR PWR=+ 4.55 dBm
CSR DLY=98.200 ns
STRT DLY=0.0000 ns
DLY WIND=500.00 ns
A TRIG=-3.00 dBm
REF PWR=4.63 dBm
7
8
9
Clear
4
5
6
GHz kW
1
2
3
dB W
0
.
—
dBm mW
F1
F2
F3
GPIB
Power
Ready
New Data
Menu
Freq
Meas
Detector Select
A
B
Peak
CW
Graph
Autoscale
Calibrator
1 GHz
Detector Input
A
B

MODEL 8501A/8502A
PEAK POWER METERS

INSTRUMENT SERIAL NUMBER ____________

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IMPORTANT NOTICE

Lithium Battery Replacement For The 8500A

It is highly recommended that the lithium battery used to power the battery-backed memory function of the instrument ***be replaced every six months***. Replacement and testing instructions are given below.

LITHIUM BATTERY REPLACEMENT (Recommended ***every six months***)

CAUTION: The following information describes a replacement procedure for the lithium battery in the 8500A. Since this procedure requires removing the top cover from the instrument and then restoring power ***before*** removing the battery, this procedure should only be performed by qualified personnel.

Lithium batteries can supply substantial current and, depending on factors such as the state of charge, can overheat when shorted.

The replacement procedure given below is intended for users knowledgeable in the use and care of equipment using non-rechargeable lithium batteries.

The 8500A uses a lithium battery to maintain power to the built-in clock chip and the static RAM used to store instrument data such as sensor linearity tables, power down status, stored setups, trace memories, limit lines, titles, etc.

Battery life varies depending on the usage of the 8500A but will be at least six months assuming normal daily use of the instrument. To save possible inconvenience that can be caused by the unintentional loss of data in the volatile memory of the 8500A, it is recommended that the lithium battery be replaced every six months.

If the instrument is placed in long term storage (over 9 months), the battery should be removed.

Recommended Replacement Battery: SAFT Type LS-6 -- Wavetek Part Number 19972

8500A LITHIUM BATTERY REPLACEMENT PROCEDURE:

1. Turn OFF the 8500A.
2. Remove the top cover.
3. Turn ON the 8500A (to maintain memory power while replacing the battery).
4. Note the polarity and orientation of the lithium battery (located on the top, center of PC board A4 - the CPU Board).
5. Remove the old battery and replace with the new one, being sure to observe the polarity and orientation of the new battery before installing it.
6. Turn OFF the 8500A, and measure the battery voltage. It must be at least 3.5V.
7. Replace the top cover and secure.
8. If desired, a label can be affixed to the instrument indicating the next replacement date.

This completes the replacement procedure.

To test for satisfactory operation of the new battery turn ON the 8500A, calibrate a detector (see page 3-10 of this manual), and check the time on the real time clock [press MENU (5) → F3]. Then turn OFF the instrument for at least one minute.

When the 8500A is turned back ON, low battery voltage or a faulty battery will be indicated by the instrument asking for a new detector calibration and failure of the real time clock to advance the time.

Addendum

About the New 8500A Power Meters

The Model 8501A/8502A Peak Power Meters incorporate a number of significant design improvements over the older Model 8501/8502 instruments. One of the most important of these improvements is the substitution of an Electro Luminescent (EL) display screen for the old LCD screen. The EL display offers a much higher degree of brightness and contrast than the LCD display. This makes it not only easier to read, but also allows the meter to be used in a low light level environment if required.

A number of operational improvements have been made to increase the "User Friendliness" of the instrument. The most significant of these improvements include the following:

- The front panel keys and their functions have been modified, and now include a key labeled PULSE/CURSOR/MARKER (P/C/M key for short). When you are operating in the Graph Mode, this key allows you to immediately select any of these three sub-modes to be able to change their parameters as desired. This used to require a series of menu displays in the old instrument. When the Graph Mode is first entered you will see all of the CURSOR parameters, pressing the P/C/M key then shows the PULSE parameters, and pressing it again displays the parameters used to place markers if markers are desired. A delta (Δ) icon is positioned next to the parameter of interest using the ↑ or ↓ keys below the EL screen. When the icon is placed, the desired value is simply input through the numeric keypad and one of the UNITS (µs, ns, or ms) keys located on the right side of the numeric keypad is pressed to enter the selection. These units keys replace the old ENTER key, and make data entry much easier. Pressing the P/C/M key a third time wraps the routine around, and back to the original CURSOR display. In the Cursor sub-mode, the spin knob can be used to change any of the displayed parameters except Cursor Power and Reference Level.

  One example of the use of the P/C/M key is in the routine required to specify the percentages of the reference power to be used to compute pulse width. Instead of the fixed 50% of rising and falling edges that had to be specified with markers in the old instrument, pulse parameters can now be entered directly with any desired percentage value. This is a better approach because the instrument can now measure the pulse and compute what the reference power should be. The old 8500 used the reference power entered by the operator or computed during autoscaling.

  The P/C/M key also allows you to quickly and easily change the Display Window and other parameters to configure the displayed pulse profile in any desired manner. When the marker sub-mode is accessed with the P/C/M key, markers can be assigned to any percentage of the reference power that you wish to enter or computed by autoscaling, and the difference readings taken at the selected points will be continuously updated. In the old 8500, the readings were not continuously updated.

- Some functions can be changed at more than one place during the testing routine. For instance, the trigger level can be changed in the menus or directly entered on the screen in the Cursor sub-mode. This allows you to do things like display channel A and trigger from channel B (with the 8502A).

- The CLEAR key can be used to exit any menu [except MENU (9) → F1 - Program Detector PROM] at any desired time. This was not consistent in the old instrument.

- The action of the spin knob has been improved to provide a much more linear, smoother, and steadier movement when the knob is used.

- Most GPIB code written for the old 8500 is still valid with the 8500A instruments. Several new commands have been added for increased versatility.

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CHAPTER 1

GENERAL INFORMATION

Wavetek Microwave, Inc. (WMI) Model 8501A/8502A Peak Power Meters

The WMI Model 8501A/8502A Peak Power Meters (PPM) are specifically designed for the analysis and power measurement of the pulsed RF and microwave signals produced by microwave component devices. The Model 8501A has a single detector input, and the Model 8502A has dual detector inputs for making ratio measurements.

The PPM converts RF energy to dc voltage by using balanced (dual Schottky diode), zero biased, detectors with very fast rise times. The dc voltage is measured with an autoranging dc amplifier, and an A/D converter provides the digitized voltage to a MC68000 microprocessor. The microprocessor accomplishes the required log functions, diode linearization, frequency response, and other mathematical functions.

The PPM can measure the power in both single and repetitive pulses as well as the power in a CW signal. Power measurements are presented on an EL (Electro Luminescent) display which allows the display of both alphanumeric and graphic information. Modes of operation are indicated both by information presented on the EL display and by LED lights on the front panel. Changes in mode or test parameters can be accomplished via the front panel keypad or, for some operations, the large spin knob on the front panel can be used as an analog adjustment for certain parameters.

GPIB (IEEE Bus) capability is standard in the PPM providing complete setup and measurement operation. Various other functions such as reporting of errors, malfunctions, operational status, and self test diagnostics are also available in the instrument.

Performance Specifications

Instrument Specifications

Frequency Range:

30 MHz to 40 GHz depending on detectors

(See the Detector Specifications, on page 1-3.)

Power Range: (Direct input to detector)

Pulse Mode:	-20 to +20 dBm
CW Mode:	-40 to +20 dBm
Absolute Maximum Limit:	+23 dBm (200 mW)

Accuracy:

The uncertainty of microwave power measurements depends on several factors, the most important of which is the effective mismatch of both the power detector and the RF source. Excluding mismatch effects, the measurement uncertainties of the instrument and its power detectors are as follows:

Calibrator Power Uncertainty (at 0 dBm):

±1.5% (0.065 dBm)

Linearity after Automatic Calibration:

±3% (at stable temperature)

Temperature coefficient of linearity at ambient ±5°C, CW and Peak, typical:

> -10 dBm	negligable,	0 to 50°C
< -10 dBm	±0.5%/deg.C,	15 to 50°C
	±1.0%/deg.C,	0 to 15°C

(The instrument indicates if the ± 5°C calibration range is exceeded.)

Uncertainty due to zeroing and noise:

CW: (Avg. = 500)	< ±10 nW, < ±20 nW,	15 to 50°C 0 to 15°C
Peak: (Avg. = 100)	< ±3.5 µW < ±5.0 µW,	15 to 50°C 0 to 15°C
Single Pulse:	< ±15 µW, (typical) < ±30 µW, (typical)	15 to 50°C 0 to 15°C

Time Base Range:

1.2 ns/DIV to 20 ms/DIV

(12 ns to 200 ms time window using either the Data Entry keyboard or the spin knob)

Resolution:	0.1 ns
Accuracy:	0.01% of time window, ±1 ns

Trigger Delay Range:

0 to 200 ms, using either the Data Entry keyboard or the spin knob

Resolution:	0.1 ns
Accuracy:	0.01% of delay, ±1 ns

Triggering Modes:

Internal:	-20 dBm to +16 dBm limited to >2 dB and < 20 dB below the peak level of the signal.
Duty Cycle:	< 50%
Trigger Rate:	10 Hz to 10 MHz
External (BNC):	TTL levels, Max PRF 1 MHz

Graph Display Mode:

Plots the outline of the detected pulse on the EL display. Also provides readout of amplitude and timing information.

Fast Measurement Mode:

Available under GPIB control to provide fast data acquisition and output.

For an averaging number = 1, typically will be between 70 and 120 measurements/second.

Also can be used to provide fast data acquisition and throughput via a rear panel analog output for using an 8500A with a network analyzer to make swept frequency response tests.

Calibrator:

Frequency:	1 GHz ±5%
Power Uncertainty at 1 mW:	±1.5%
Return Loss at 1 mW:	Greater than 25dB
Self Calibration Time:	Less than 1 minute
Connector:	Type N

Auxiliary Outputs/Inputs: (BNC)

Monitor:	Provides a voltage proportional to the detected RF envelope. Rise-time is typically 20 ns, output impedance is nominally 50 ohms.
Analog Output Coefficient:	100 mV/dB ±0.5 mV (0V = 0 dBm)
Offset:	±10 mV
Trigger Input:	TTL
RF Blanking:	TTL open collector low during zeroing. Used to control power source.
Voltage ∝ Frequency: (V/GHz)	Allows direct entry of frequency from RF power sources equipped with a V ∝ F output.

GPIB Interface:

Per IEEE STD 488-1978

GPIB Indicators: REM, TLK, LSN, SRQ, LLO

Remote Operation:

Complete setup and measurement capabilities accessible via GPIB (IEEE-488). Reporting of errors, malfunctions, operational status, and self-test diagnostics available through serial poll capability.

Direct Plot Output:

Outputs hardcopy pulse profile plots, with time, date and part identification, to a GPIB plotter.

GPIB Address:

Selectable from front panel

IEEE Interface Functions:

SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, TEO, LEO

General:

Stored Setups:	Saves settings at power down, and has 10 additional setups in non-volatile memory.
Self-Test:	Self-test is optionally performed at any time. A diagnostic code indicates the cause and location of any errors.
Reset Control: (Rear Panel)	Returns instrument to present default condition.

Design and Construction:

To the intent of MIL-T-28800C, Type III, Class 5, Style E or F, Color R

Power Requirements:

100, 120, 220, or 240VAC ±10%
50, 60, or 400Hz ±5%

Power Consumption: Approx. 100VA

Environmental Characteristics:

Temperature:

Operating:	0 to 50°C (+32 to +122°F)
Non-operating:	-40 to +65°C (-40 to +149°F)

Humidity:

Operating: (without precipitation:	95% ±5% to 30°C 75% ±5% to 40°C 45% ±5% to 50°C

Physical:

Dimensions: (H x W x D)

Bench Mount:

With Feet:

148.3 x 425.7 x 355.6 mm
(5.84 x 16.76 x 14.00 in.)

Without Feet: (Instrument Only)

132.6 x 425.7 x 355.6 mm
(5.22 x 16.76 x 14.00 in.)

Rack Mount:

132.6 x 482.6 x 355.6 mm
(5.22 x 19.00 x 14.00 in.)

Conforms to EIA RS-310 Standard for a 19" rack.

Weight:

Model 8501A:	12 kg (26 lbs)
Model 8502A:	13 kg (28 lbs)

Detector Specifications

Frequency Ranges:

High Speed:	750 MHz to 18.5 GHz 750 MHz to 26.5 GHz 750 MHz to 40 GHz

(High speed detectors can be used down to 500 MHz.)

Low Speed:	30 MHz to 18.5 GHz 30 MHz to 26.5 GHz

Rise Time:

High Speed:	< 15 ns (Typical = 12 ns)
Step Response:	Ringing < ± 5%, settling to < ± 2% in 200 ns
Low Speed:	< 750 ns (Typical = 500 ns)

Power Range:

Measurement: -20 to +20 dBm (Pulse)
-40 to +20 dBm (CW)
Absolute Maximum: +23 dBm (200 mW)
(Damage Limit)

Return Loss (SWR):

	Type N, APC-7	Type K
Below 2 GHz	25 dB (1.12)	25 dB (1.12)
2 to 12.4 GHz	20 dB (1.22)	20 dB (1.22)
12.4 to 18 GHz	16 dB (1.37)	16 dB (1.37)
18 to 26.5 GHz		14 dB (1.50)
26.5 to 40 GHz		10 dB (1.92)

Calibration Factor Uncertainty: (at multiples of 1 GHz)

Frequency	Sum of Uncertainties (%) [1]	Probable Uncertainties (%) [2]
Below 10 GHz	2.6%	1.2%
10 to 18 GHz	6.4%	3.7%
18 to 26.5 GHz	10%	6.5%
26.5 to 40 GHz	20%	10%

[1] Includes uncertainty of reference standard and transfer uncertainty. Directly traceable to NIST (formerly NBS).

[2] Square root of the sum of the individual uncertainties squared. (RSS)

Measurement Uncertainty:
(Root of the sum of the squares)

The total Measurement Uncertainty will consist of the Calibration Factor Uncertainty (see the preceding table) plus the Calibrator Uncertainty at 1GHz (= 1.5%) plus the Mismatch Uncertainty of the Calibrator and Detector at 1GHz (= 0.6%) plus the Linearity if not near 1mW (= 3%) plus the uncertainty due to noise if operating at low signal levels plus the Mismatch Uncertainty of the Detector and Source under test.

Typical Example:

Frequency = 6 GHz, Source Return Loss = 10dB

Calibration Factor uncertainty at 6 GHz: 2.6%

Calibration uncertainty at 1 GHz: 1.5%

Mismatch uncertainty of Calibrator and Sensor at 1 GHz: 0.6%

Linearity: (if not near 1 mW) 3.0%

Noise: (see preceding section on Accuracy) ±3.5 μW

Mismatch of sensor and source: 3.2%

Total mismatch uncertainty = 10.9% ±3.5 μW

RSS Value = 5.34% ±3.5 μW

Physical:

Dimensions:

37 mm (1.44 in.)	Diameter
133 mm (5.25 in.)	Length

Weight: 0.3 kg (0.7 lbs)

For complete descriptive information regarding all detectors available for the Model 8500A instruments see the Technical Information publication, "RF Detectors for the Model 8501A/8502A Peak Power Meters" included with this manual (in the vinyl pocket inside the front cover).

CHAPTER 2

INITIAL INSTRUCTIONS

Receiving Inspection

Inspect the instrument for shipping damage. Be sure that all portions of the shipment are located before discarding any packing material or shipping containers. (See Chapter 6 if a Performance Verification test is required.)

Power Requirement

WARNING: Before applying ac mains power to the instrument, be sure that the instrument is set for the correct line voltage.

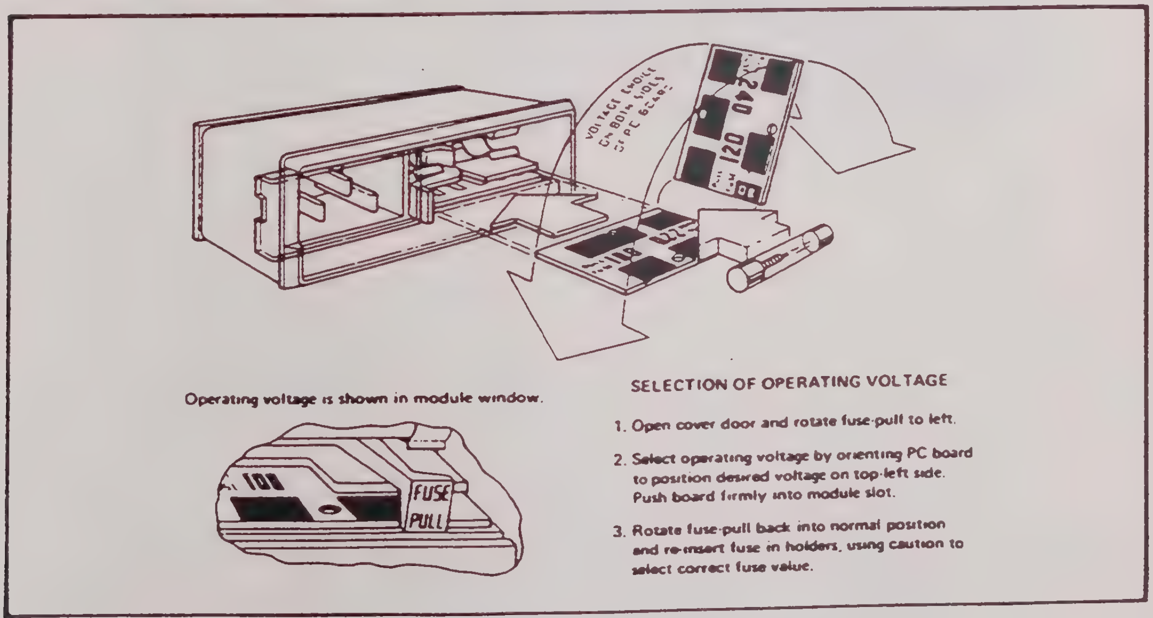
The unit is set at the factory for operation at the normal supply voltage for the country in which it is sold. The input frequency must be 50, 60, or 400Hz 5%. The combination of the module and transformer design allows instrument operation of 100/120 volts (uses 2A Slo-Blo fuse), or 220/240 volts (uses 1A Slo-Blo fuse). Conversion from one voltage to another can be made by changing the voltage selection PC board. (See Figure 2-1, below.)

Chassis Grounding

DANGER: FAILURE TO ENSURE THAT THE INSTRUMENT IS PROPERLY GROUNDED COULD ALLOW HIGH VOLTAGES TO BUILD UP ON THE CHASSIS. THE VOLTAGE CAN REACH LEVELS THAT COULD BE DANGEROUS TO OPERATING PERSONNEL.

The instrument is supplied with a three-conductor NEMA type power cord. The current carrying conductor is black and its return is white.

The green wire of the power cord is for connection to earth ground. The instrument will be properly grounded if the plug is connected to a properly installed three-prong receptacle. If a three-prong to two-prong adapter is used, be sure that the pigtail lead of the adapter is earth-grounded.



Operating voltage is shown in module window.

SELECTION OF OPERATING VOLTAGE

1. Open cover door and rotate fuse-pull to left.
2. Select operating voltage by orienting PC board to position desired voltage on top-left side. Push board firmly into module slot.
3. Rotate fuse-pull back into normal position and re-insert fuse in holders, using caution to select correct fuse value.

Figure 2-1. Instrument Operating Voltage Selection

Detector Precautions

The Model 8501A/8502A detectors are configured in a metal housing to provide superior mechanical performance as well as excellent shielding. When connecting the detectors to other devices or components it must be remembered that **THE BODY OF THE DETECTOR SHOULD NEVER BE TURNED IN ORDER TO TIGHTEN THE RF CONNECTION.** Mechanical damage may result if improper handling is attempted when connecting the detectors.

WARNING: All Wavetek Model 8501A/8502A detectors contain balanced, zero biased Schottky diodes for power sensing. If the detector is connected to CW or Peak power devices whose power output is in excess of +23 dBm (200mW) degradation or total destruction of the diode can occur. DIODES DEGRADED OR DESTROYED IN THIS MANNER WILL NOT BE REPLACED UNDER WARRANTY.

Returning the Instrument

If it is felt that the instrument should be returned to Wavetek Microwave for any reason, it is recommended that the Wavetek Microwave Customer Service Department be contacted before the unit is sent back. It is often the case that many problems can be resolved by telephone or Telex without the necessity of returning the instrument. The telephone number is (408) 734-5780, extension 260, or Telex 3716460.

CHAPTER 3

OPERATION

Introduction

The Model 8501A/8502A meters are designed to be very simple to operate. The operator basically has only to follow the instructions given in the prompts and menus shown in the EL (Electro Luminescent) display window to set up the necessary parameters for making a measurement. Eleven levels of specific, operational menus are available that can be accessed with the MENU key. The type of measurement (Peak or CW) being made at any particular time will also be shown in the lower right corner of the EL window to remind the operator which mode is in use.

Along with the menus and prompts given on the EL display, the 8501A/8502A meters use three different audible tones to indicate the occurence (or non-occurence) of certain events during setup and testing. These tones are called "clicks", "chimes", and "warble", and are defined as follows:

Click: When a key is pressed and a "click" is heard, this means that the key is active and its function will be included in whatever parameters are being keyed in at the time. If no click is heard, the key is not active and not performing any function at that time.

Chime: A "chime" is heard when a function that takes a specific amount of time to complete, such as self test or auto zero, has completed. Further commands can then be keyed in.

Warble: The "warble" tone is heard when a self test or calibration function does not pass due to an error of some type. An error message will be presented on the EL display screen.

The actual sounds and usage of these tones will become apparent while the first operational sequence is being performed. There is a volume control on the rear panel of the instrument which can be used to adjust the audio tones to any desired level.

NOTE: In the remainder of this section, except where specified as Model 8501A or 8502A, the instrument will be referred to as just "PPM" (Peak Power Meter).

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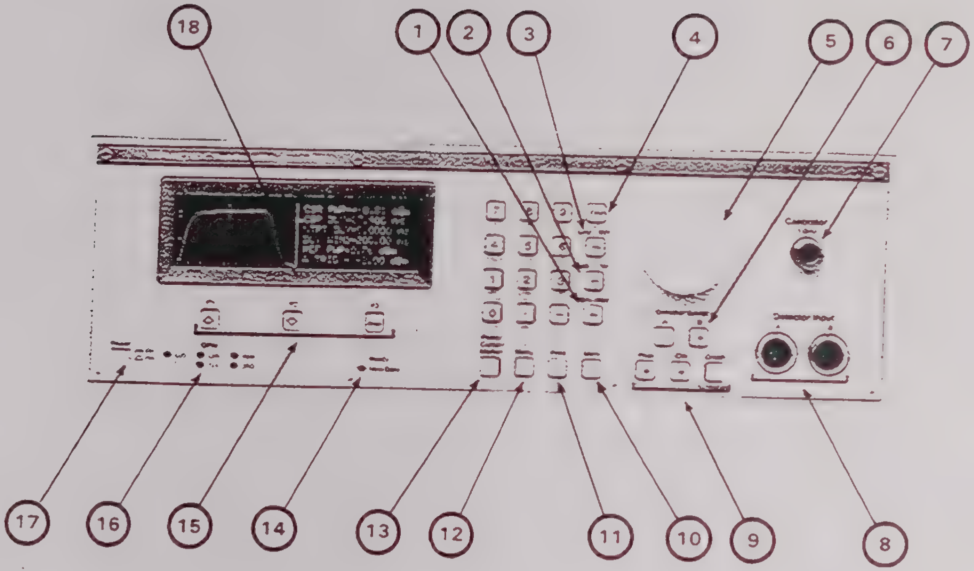
18
1
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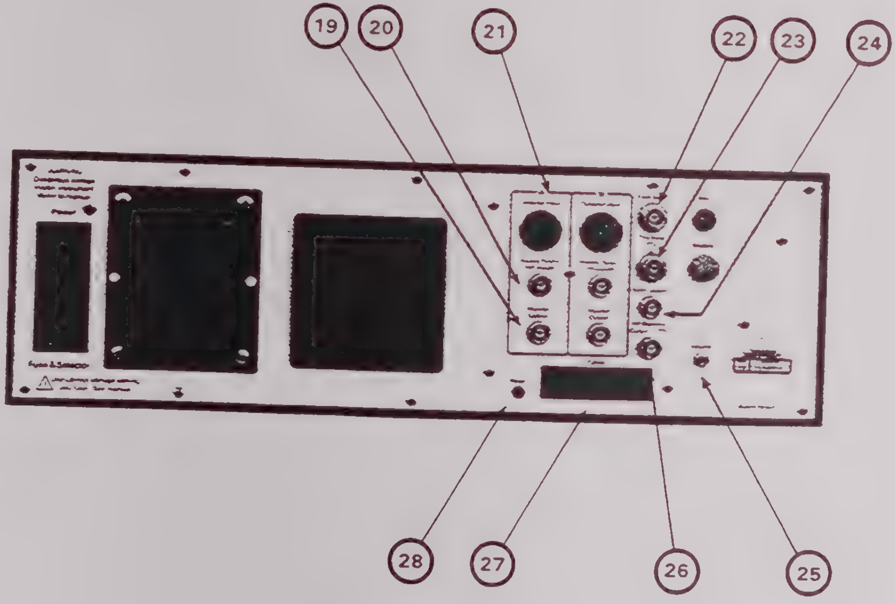
FRONT VIEW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26
25

REAR VIEW

Figure 3-1. Model 8501A/8502A Controls, Connectors, and Indicators

(See the corresponding numbers in the next section, Front and Rear Panel Controls, for descriptions)

Front and Rear Panel Controls, Connectors, and Indicators

NOTE: The "Peak", "CW", and "Graph" keys of both instruments, and the "Detector Select A" and "B" keys of the Model 8502A contain lights located in the center of the buttons to indicate when the function is active.

Front Panel Description

1. **ns / dBm mW** Key

The ns key is used to enter pulse timing parameters in nanosecond units.

The dBm mW second function of the ns key is used to enter a power parameter in either dBm or milliwatts.

2. **µs / dB W** Key

The µs key is used to enter pulse timing parameters in microsecond units.

The dB W second function of the µs key is used to enter a power parameter in either dB or Watts.

3. **ms / GHz kW** Key

The ms key is used to enter pulse timing parameters in millisecond units.

The GHz kW second function of the ms key is used to enter a frequency in GHz or (with offsets) to enter a power parametert in kilowatts.

NOTE: All of the UNITS (ns, µs, and ms) keys described above have a third function. At various points in these instructions, the discussion will state to "press any Units key" (often abbreviated to just "UNITS"). This is done to either enter a parameter without units (average number), or with other units than listed above (start voltage), or to start a function.

4. **CLEAR** Key

The CLEAR key is normally used to escape from a menu, but it can also be used to clear erroneous entries that might be made by the operator.

5. **SPIN KNOB**

The spin knob used to change the value of selecte parameters. The ability to use the knob will be indicated on the display by the appearance of a delta symbol (Δ) next to the name of the parameter of interest. For instance, when in the Peak Mode, activating a Cursor Delay entry will cause the "Δ" symbol to appear next to the "DLY" indication in the power reading display. This means that the spin knob can be used to change the Cursor Delay setting.

6. **DETECTOR SELECT A or B** (8502A only)

These keys are used to select which channel should display data on the Model 8502A display. They are also used at times to tell the instrument which channel a trigger level entry is intended for.

In the CW and Peak Modes it is possible to display measurements for either channel A, channel B, or both at the same time. In the Graph Mode, only one channel at a time can be viewed.

When the 8502A Ratio Mode is in use, the A and B keys call up a menu so that the type of signal to be ratioed (CW or Peak) can be specified for the selected channel. This is useful for cases where it is desired to determine the ratio between a CW and a Peak signal. For example, a radar TWT might have a pulsed output, but its input could be CW. To measure its gain, the Peak output would have to be divided by the CW input. The 8502A does this instantly and automatically.

7. **CALIBRATOR** Connection

The CALIBRATOR connection is used for the automatic calibration of the PPM's detectors. The detector's frequency response characteristics are read over its entire dynamic range from the factory-measured data stored in the PROM inside the detector housing, and then used for normalizing the power readings during test routines. (See the Self-Calibration Procedure on page 3-10.)

8. **DETECTOR INPUT** Connections

These receptacles provide the input from the A and B channel detectors in the Model 8502A. The Model 8501A has a single input.

9. **PEAK, CW, GRAPH** Keys (Mode Keys)

These keys select whether the PPM will be used for CW or Peak power measurements. GRAPH is used when making Peak power measurements to allow the graphic display of the detected pulse and easy determination of pulse timing factors. In addition to the EL (Electro Luminescent) readout display indications, the selected mode is also made obvious by noting which LED in the center of the PEAK, GRAPH, and CW keys is lit. If the Model 8502A is being used for Dual Channel operation and all of the mode LED's are out, then it is in the Ratio Mode. (See Power Ratio Measurement Procedures on page 3-24.)

10. MEM Key

The MEM key can be used to activate three Memory Menus. Pressing the key once causes the display of Memory Menu #1. Pressing the key twice shows Memory Menu #2, and three times shows Memory Menu #3. Pressing CLEAR returns the routine to the Data Display Mode.

The Memory Menus control the usage of the PPM's non-volatile setup memories. The contents of the 10 available memory locations can be Stored, Recalled, Initialized, and Displayed. The menus also give the user the option to return to the current test setup (the one in use just before the MEM key was pressed), as well as the option to return to the initial power-on status. See the Non-Volatile Memory discussing starting on page 3-31 for more information on the PPM's memory capabilities.

11. FREQ Key

The FREQ key is used to enter the signal frequency for the channel A and B detectors. When the default setting of the instrument is in use, all that is required is the entry of the frequency of the specific signal being tested.

If the PPM is in the Cal Factor or V/GHz setting, pressing the FREQ key will allow the user to change these parameters by following the prompts.

12. MENU Key

The MENU key allows access to the eleven Main Menus of the PPM. Depending on the mode of operation, other keys can cause the display of submenus that pertain to the particular function of that key. However, the MENU key will cause the routine to step through each of the Main Menus each time it is pressed. If it were pressed, say, three times, then Menu #3 [or simply MENU (3)] would be presented on the display.

A specific description of each menu that will be presented at each keystroke of the MENU key is given in Appendix B, starting on page 3-39 of this chapter. Wherever possible, commands or user selections that would normally be used more often are located at the "top" of the menu structure [i.e. MENU (1) through MENU (4)]. Less commonly used menus are located toward the "bottom" of the menu structure [i.e MENU (5) through MENU (11)].

13. PULSE/CURSOR/MARKER Key

This key is only active in the Graph Mode. Pressing the key cycles the PPM through the three sub-modes PULSE, CURSOR, and MARKER. The CURSOR sub-mode is convenient for changing the time base parameters, scaling, trigger level, and cursor position. The PULSE sub-mode displays the Rise Time, Fall Time, and Pulse Width of the current pulse. The MARKER sub-mode displays the time between four user-defined power levels on the pulse.

14. "Ready" and **"New Data"** Indicators

These LEDs flash whenever the system is receiving a trigger. If the "Ready" light is steadily on and the "New Data" light is off, it would indicate that a trigger was not being received.

15. ↑, ↓, Bksp / F1, F2, F3 Function Keys

The ↑ and ↓ keys are used in the Graph Mode to move the Δ icon up and down to select any pulse or cursor parameters that are to be changed. The Backspace key is used when entering alphanumeric data to correct any improperly entered text or numbers.

The F1, F2, and F3 second function of these keys are used to select menu functions as the various menus are displayed on the EL display screen.

16. GPIB Indicators

These LEDs indicate whether the PPM is under local or remote (REM light on) control, and the current GPIB status. (LSN = listen, TLK = talk, SRQ = service request, and LLO = local lock-out.)

17. POWER Switch

This is a push-push type switch used to turn on and off the ac power to the PPM.

18. EL Display Screen

This is the PPM's Electro Luminescent (EL) alphanumeric and graphic display screen which is used to present data and show pulse waveform profiles.

Rear Panel Description

19. MONITOR Output

This connection can be used to interconnect a test instrument such as an oscilloscope to externally monitor the detected signals entering the PPM.

20. ANALOG Output

100mV/dB output for interfacing the PPM with the WMI Model 8003 or 1038-NS20 or N10 Scalar Analyzers for making swept peak power measurements. (See Measuring Peak Power Under Swept Conditions on page 3-29 for description).

NOTE: When using the PPM in the 1018B Emulation Mode, it should be kept in mind that the 1018B instrument has a 10 mV/dB analog output while the PPM has 100 mV/dB. If the 10 mV/dB output of the 1018B is required, a 10:1 resistive divider network should be employed to reduce the PPM's 100 mV/dB output.

21. DETECTOR Inputs

These channel A and B inputs (the single input of the 8501A) will be just blank cover plates unless option 03 (Rear Panel Connection) has been specified. In that case, the Detector Input and Calibrator connections will not be present on the front panel and will, instead, be located here. The Calibrator connection would be above the Serial/Code number label on the right side of the rear panel.

22. FREQ Input

This is a voltage proportional to frequency input connection that can be used to receive the Frequency Reference or V/GHz output signal from an external signal generator. This signal can be used to provide frequency information to the PPM for detector frequency response correction when required.

23. TRIG Input - TTL

This connection is used to interface a signal source to provide an External Trigger when this mode of operation is desired.

24. SYNC Output

For synchronizing the PPM to an external counter.

25. VOLUME Control

This control can be used to adjust the volume level of the audio tones generated by the PPM.

26. RF BLANKING Output - TTL

A blanking signal is available here that can be used to turn off the RF power of the external signal source when it is desired to autozero or calibrate the detectors.

27. GPIB Connection

This is the interface connection for controlling the instrument through the GPIB (IEEE Bus).

28. RESET Switch

This control is available to return the PPM to an initial "power-on" condition without having to turn off the instrument.

Initial Procedures

Basic operation of both the Model 8501A (single detector) and the Model 8502A (dual detector) meters is essentially the same for making standard peak power and CW measurements. The single channel 8501A does not, of course, have the ratio measurement capability of the dual channel 8502A. The following instructions are generally written to define the operation of both instruments. If a Model 8501A is being used, please ignore references to "A" and "B" keys, distinctions between the "A" and "B" channels, and reference to two detectors. (The single channel of the 8501A is considered to be channel A for definition purposes.) If the instructions require that a distinction be made between the two instruments, the specific model number will be given rather than "PPM".

Power On Procedures

1. Before turning on the power to the PPM, be sure that it is set for the correct input voltage. (The Power Requirement section of the Initial Instructions given in Chapter 2 describes the setting of the operating voltage.)

2. Connect a detector to the PPM's front panel DETECTOR INPUT connection (channel A) using the Wavetek detector cable (P/N 16956-XXX) supplied with the system. (See the next para-

graph for connection instructions.) If a dual channel Model 8502A is to be used, detectors should be connected to both the channel A and channel B inputs for dual channel operation.

To connect the cable to the detector housing pull back on the metal sleeve at the detector end of the cable, align the red dots, and make the connection. To connect the other end of the cable to the front panel DETECTOR INPUT receptacle, again pull back the metal sleeve, align the red dots on the cable and input receptacle, and make the connection.

3. Turn on the power by pressing the power switch at the lower left corner of the front panel.

NOTE: The detector must either be connected to the CALIBRATOR OUTPUT connection on the front panel, to a "50 ohm Termination", or to a "Signal Source" before initiating the Self Test function.

4. The PPM will perform a Self Test to verify that it is operating properly.

NOTE: This Self Test is not identical to the one performed by selecting MENU (11) → F2, or by sending the SELT command over the GPIB. The power-on self test will not report errors 5 or 6 because the user may not have removed RF power from the detectors, or error 10 because it sometimes fails erroneously soon after power on.

5. The PPM will automatically return to the last setup before the instrument was powered off.

Warm Up Time & Temperature Indication

When initially operating the PPM, it is common to see a prompt on the display stating "RECAL: dT XXX DEGS-C." The number of degrees shown is the difference between the present temperature of the detector and the temperature at which it was last calibrated.

The prompt only occurs if the change in detector temperature is more than 5°C. When this prompt is displayed it means that sufficient time should be allowed for the instrument to warm up so that accurate readings can be taken. Variations of less than 5°C from the calibration temperature do not result in a temperature prompt display because minor temperature changes in the detector are monitored and compensated by the 68000 microprocessor.

If the PPM continues to display the temperature prompt after 30 minutes warm up or if the room ambient temperature changes by more than 5 degrees Celsius, a Self Calibration will be required. (See Self Calibration Procedure on page 3-10.)

Mode Selection

Selecting CW Operation

If in the Peak or Graph mode, press CW to access the CW Mode.

If a menu is being displayed and it is desired to escape and go to the CW Mode press:

CLEAR → CW

NOTE: If the Model 8502A is being used in the Ratio mode, selecting CW will cancel RATIO and the 8502A will display the CW power of channel A.

In certain instances the option will be given to select the CW Mode if there is some reason that another mode is not operating properly. For example, if a trigger had not been provided as required in the Peak Mode. The purpose is to allow an escape from erroneous modes of operation.

Very few adjustments or menu selections are required to set up the unit for CW measurements. The two major settings that must be specified are defined as follows:

A. Frequency

(See the FREQ Key description. Number 11 on page 3-5.)

Selects the operating frequency at which the power will be measured. Normally, the PPM will automatically adjust for detector frequency response variations by using the factory measured frequency response data stored in the PROM in the detector housing. Other options are available as detailed in PROM Frequency Correction on page 3-11. Not compensating for the frequency response of the detector could result in an error in the power measurement reading.

B. CW Averaging

Selects how many samples of the signal being measured will be taken and averaged to reduce noise effects at low power levels. To adjust the averaging number, press MENU twice, then F1. A number between 1 and 999 averages must then be entered. Note that the number of averages presently in effect is not indicated until the averaging menu has been entered.

Low Power Level Measurements

(below -30 dBm)

When the PPM is used in the CW mode, its dynamic range is extended to below -40 dBm. Under low power testing conditions, it is necessary to observe the correct auto-zeroing procedures in order to obtain the highest measurement accuracy. Periodic zeroing should be done more often in environments where the temperature changes drastically. (See Auto-Zero Function on page 3-11 for the auto-zeroing procedure.)

Selecting Peak Power Operation

If in the CW or Graph Mode, Peak is accessed by pressing PEAK

If a menu is being displayed and it is desired to escape to the Peak Mode press:

CLEAR → PEAK

After this, follow the trigger setting guidelines given below. Lack of a trigger can cause a frozen display. To exit either of these situations either the trigger can be set, or the CW Mode can be re-accessed by pressing the CW key.

Triggering

To be able to make measurements in the Peak (or Graph) Mode, the first thing that must be done is to ensure that the system receives a triggering signal that will drive its timebase and crystal based delay generator. After this is done, the delay generator functions to accurately place a sampling window at the desired time on the pulse to be measured. The different triggering methods are detailed below.

INTERNAL TRIGGERING

The PPM can generate its own Internal Trigger from the detected RF video envelope at the detector output. This triggering mode requires that the power of the RF pulse be greater than the Internal Trigger Level. The Trigger Level is an adjustable threshold at which the rising, leading edge of a pulse will cause the PPM to take a reading. The precise time at which a reading is taken following the trigger is determined by the delay generator. This function of the PPM is called Cursor Delay. [See the Cursor Delay (CSR DLY) description given in part B of Cursor Sub-Mode Functions on page 3-18.]

There are two trigger amplifiers in the PPM, one for the range -20 dBm to -10 dBm and another for the range -10 dBm to +16 dBm. Selecting trigger levels in the lower range (below -10 dBm) can cause the trigger to be delayed on the order of 100 ns due to the filtering required to improve trigger stability at these low levels. The absolute accuracy of the trigger level is about ±1/2 dB near the top of these ranges, but degrades to about ±2 dBm near the bottom.

Normally, the Trigger Level is set at -10 dBm (default). The internal trigger level can be adjusted if desired by pressing MENU once, then selecting F1. A trigger level value between -20 and +16 dBm can then be entered.

NOTE: If there is no RF pulse present at the detector input or if the pulse amplitude is too low, the PPM will not internally trigger. When this occurs the EL display will freeze, the "New Data" light will not be lit, and the "Ready" light will not be on.

If a dual channel Model 8502A is being used, the routine will ask whether internal triggering is to be driven by inputs from channel A or channel B. Selection is made by pressing the appropriate DETECTOR SELECT A or B key. To select the Internal Trigger Mode and set the level press:

(8501A) MENU (1) → F1 → nn.nn → UNITS
or
(8502A) MENU (1) → F1 → A (or B) → nn.nn → UNITS

(nn.nn = selected trigger level numbers)

Autoscaling changes the internal trigger channel to the displayed channel.

EXTERNAL TRIGGERING

For some test routines it may be desirable to provide an external trigger to the system. This can be especially useful if the trigger pulse from the external source leads the RF pulse at the detector input by a small amount of time. Readings can then be taken just prior to the arrival of the RF pulse allowing close inspection and measurement of the pulse's leading edge.

To use the External Trigger Mode, connect a BNC cable from the TTL sync pulse output of the system under test (or pulse generator) to the External Trigger input on the rear panel of the PPM. To select the External Trigger Mode, press the MENU key once, then select F2. After this has been done, correct operation of the External Trigger Mode is verified by noting that the "Ready" and "New Data" lights on the front panel are flashing.

If an attempt is made to operate in the External Trigger Mode without supplying the required trigger as described above, the EL display will freeze, the "Ready" light will be on, and the "New Data" light will be out.

To select External Trigger press:

MENU (1) → F2

Selecting Graph Mode Operation

If in the Peak, CW Mode, or Ratio Modes (previous Graph or Peak Mode settings will apply), press GRAPH.

If a menu is being displayed and it is desired to escape to the Graph Mode, press:

CLEAR → GRAPH

Then, to Autoscale the pulse, press AUTOSCALE

NOTE: While in the Graph Mode the second function of the GRAPH key, AUTOSCALE, will be active .

Under some conditions, autoscaling cannot take place due to the complex shape of the pulse or other timing factors. The PPM will then display only a part of the pulse on the EL display. The reference level will be correct for rectangular pulses. The PPM will not have been able to set an appropriate Delay Window for the pulse. It may be possible to subsequently autoscale by changing the initial delay value for autoscaling to be closer to twice the actual pulse width for the pulse in question. This is done by selecting:

MENU (9) → F2 → n.nnnn → UNITS

NOTE: To use the Graph Mode, the triggering selection guidelines discussed under Triggering on page 3-8 must be followed.

General Information

The Graph Mode of the PPM provides graphic capabilities for the display, plotting, and analyses of RF pulse profiles. Most instrument pulse parameters can be set and changed directly from information presented in menus on the EL display screen. Features are available which allow measurement of commonly required pulse parameters such as risetime, pulse width, etc.

When the system is operating satisfactorily in the Peak or Graph Mode, it is possible to toggle back and forth between the two modes by pressing the PEAK or GRAPH keys whenever desired. The only exception to this is when an 8502A is being used in the dual channel mode of operation since the Graph Mode does not allow dual channel operation. If a dual channel function is being used and it is desired to switch to the Graph Mode, single channel operation must first be selected. (See Dual Channel Operation, Method 2, on page 3-23.)

The ability to toggle back and forth between Peak and Graph Modes is useful for a number of reasons. For example, in the single channel Peak Mode, the EL display produces very large, distinct power readout characters that can be read from a distance. (See Figure 3-2 on page 3-15.) In addition, while in the Peak Mode, the current frequency being used for the test is directly visible on the display. In the Graph Mode, the display is primarily used for inspection of the pulse profile and the frequency is not displayed to allow room on the display for other important pulse profile parameters. (See Figure 3-3 on page 3-17 for a typical Graph Mode display.)

All operating parameters such as trigger mode, frequency, and cursor delay are maintained in both the Peak and Graph Modes. The Graph Mode can be used to place the cursor at a specific point on the pulse, and then the PEAK key can be pressed to see the power reading displayed using the large readout characters.

Self-Calibration & Auto-Zeroing

General Information

The purpose of the PPM's Self-Calibration (Self-Cal) function is to ensure that measurement accuracy will be maintained despite changes in detectors, changes in detector diode temperature, or other changes that might occur in the PPM's analog circuits.

During the time the instrument is performing its Self-Cal routine, the RF output of the 1 GHz calibrator is accurately stepped from +20 to -30 dBm. Each step is measured by an internal standard and, at each point, the calibrator output power as measured by the RF detector is compared to the standard. The power readings are then digitally adjusted by the PPM's microprocessor and stored in memory. For power levels below -30 dBm, the system relies on the Auto-Zero function as well as the inherent repeatability of the detector's voltage output versus input power at these levels. (Refer to page 5-32 of the Electrical Description chapter for a complete description of the automatic calibration system.)

In order to make any type of power measurements with the PPM it will be necessary to use the appropriate calibration and zeroing procedures to ensure the highest accuracy.

After the instrument has warmed up for 30 minutes and the mode of operation has been selected, a detector self-calibration should be performed. In addition, if the ambient room temperature changes more than 5°C from the temperature at which the system was last calibrated, self-calibration should also be done. If there has been a change in the temperature of the detector of more than 5°C since it was last calibrated, the difference will be shown.

Self-Calibration Procedure

1. Connect the channel A detector to the 1 GHz CALIBRATOR output connection.

2. Press the MENU key once, then press F3 to call up the Cal or Zero Detectors menu.

3. The menu offers the following choices:

F1 to Calibrate the Detectors	*F2 to Auto Zero the Detectors*	*F3 to Return to Data Display*

Select F1 for the detector self-calibration.

NOTE: The CLEAR key can also be used to return to data display (as well as F3, above).

4. The display will then show the last date and time the detector was calibrated. To proceed with the calibration, press any Units key. The Self-Cal process takes about 50 seconds during which time the statement "A (or B) CALIBRATION IN PROGRESS" will be displayed.

If a Model 8501A is in use, pressing the CLEAR key will return the routine to the data display (the last mode of operation). If the Model 8502A is being used, pressing the CLEAR key will bypass the channel A calibration and go to the channel B calibration.

After successful completion of the Self-Cal function, the instrument will go back to displaying data in the last mode of operation. With the Model 8502A, either bypassing or successfully completing the channel A calibration will take the routine to the channel B calibration.

5. Channel B calibration is done in the same manner as the channel A calibration. The date and time of the last B channel calibration will be presented, and the option will be given to either press any Units key to start the cal procedure or to press CLEAR to return to the data display.

Self-Calibration Failures

In the event of some type of malfunction such as a burned out detector diode or if the operator forgets to connect the detector to the calibrator, the Self-Cal function will fail. If this occurs, the following error menu will be displayed:

A Calibration Error Exists
Press CLEAR to Continue
Press any Units key to Repeat Cal

Selecting CLEAR returns the instrument to the last mode of operation.

Selecting any Units key gives the operator the opportunity to correct a simple error such as not connecting the detector to the calibrator. This can be accomplished, and then the Self-Cal procedure can be repeated.

(See #6 of the Input/Output & Calibration Failure descriptions on page 7-14 of the Maintenance chapter of this manual for the procedure to follow if the PPM fails the Self-Cal.)

Auto-Zero Function

To initiate the Auto-Zero function, turn off the RF power to the detector to be zeroed and then press the MENU key once. Select F3 to get to the Self-Cal/ Auto-Zero menu. Then select F2 to Auto-Zero and follow the displayed prompts.

The keystrokes to Auto-Zero are:

MENU (1) → F3 → F2

If the Model 8502A is in use, channel A must be Auto-Zeroed before channel B. If desired, channel A can be bypassed by pressing CLEAR and going directly to channel B.

Measurement Procedures

Frequency Correction, Cal Factor, and dB Offset

The Frequency Correction and Offset functions are used to enhance measurement accuracy, and to compensate for detector amplitude and frequency response variations as well as devices residual to the test setup.

Frequency correction is selected in Menu #3. Three methods of frequency correction are available (and will be described in detail in this section). These are:

a) PROM Table -- User Supplied Frequency (default mode).

b) PROM Table -- External Frequency Input (uses the 1V/GHz output of the sweeper)

c) User Supplied Calibration Factor (allows direct entry in dB)

To select the desired mode, press:

MENU (3) → F3

Then select F1, F2, or F3 respectively, for items a, b, or c. This will determine the functioning of the FREQ key of the instrument.

Whenever a mode is selected that will use the PROM table in the detector assembly for frequency correction, the PPM will interpolate between the discrete amplitude correction points stored in the detector's PROM. This allows entry of frequencies other than those stored in the PROM, and reduces the need for operator interpretation and manual correction of power readings.

NOTE: All of the information stored in the PROM of the detector currently in use can be reviewed by accessing MENU (10) and pressing F2 for channel A, and/or F3 for channel B (for the 8502A).

PROM Frequency Correction

(User Supplied Frequency)

This is the default mode of the instrument. Factory measured frequency correction data is stored in a PROM inside the detector housing, thus eliminating the need for the operator to refer to a frequency correction chart and then make manual adjustments to the system for each discrete frequency point. The PROM data is used by the PPM to correct for all of the detector's amplitude variations across its entire frequency range. When the system is first turned on, the PROM data stored in the detector (or detectors) is transferred to the main memory of the PPM.

To select the "PROM Table - User Supplied Frequency" mode, press:

MENU (3) → F3 → F1

The display will then ask for the frequency of operation to be entered. The default frequency is 1 GHz, the same as that of the Calibrator. Press any Units key to complete the entry.

After selecting the "PROM Table - User Supplied Frequency" mode, use of the FREQ key allows entry of the Carrier Frequency and gives the microprocessor the ability to correct for any detector frequency response deviations.

PROM Frequency Correction

(External Frequency Input)

The purpose of the PROM Frequency Correction function is to allow entry of the operating frequency by means of an externally applied voltage. The voltage level will be proportional to the frequency, and will be used by the PPM to correct power readings for detector frequency response.

When this function is active, the RF frequency of a sweep generator or signal source can be changed and the PPM will convert the analog voltage input (coming in through the rear panel FREQUENCY INPUT connection) to a digital representation of the frequency. The PPM's microprocessor then uses this information to correct power readings according to the frequency correction table stored in the detector's PROM.

If the sweep generator (sweeper) is equipped with a rear panel output providing frequency information, this information will usually consist of an analog voltage proportional to the RF frequency output of the sweeper at any given time. Some sweeper manufacturers refer to this voltage as "Frequency Reference", "Volts/GHz (V/GHz)", or "Voltage Proportional to Frequency" ($V \propto F$). The most common coefficients for this output are 1V/GHz and 0.5V/GHz.

Once the $V \propto F$ frequency correction function has been activated, the FREQ key can be used to change the parameters for use by the $V \propto F$ function.

To activate the $V \propto F$ frequency correction function, perform the following:

1. Connect a BNC cable from the V/GHz output of the sweeper to the FREQUENCY INPUT connection on the rear of the PPM.

2. Make the following keypad entry:

   MENU (3) → F3 → F2

   The instrument will then ask for the sweeper V/GHz value (will normally be 1 or 0.5). Press n.n → any Units key (where n.n is volts).

   The Sweeper Start Voltage is required next. If the sweeper's frequency range is from 2 to 18 GHz and the sweeper V/GHz coefficient is 0.5V/GHz, then this value would normally be 2 x 0.5 = 1. Press any Units key to complete this entry.

   The last entry required is the Sweeper Start Frequency. If the same sample shown above were used, then the value entered would be 2. Press any Units key to complete the entry.

The above steps set the frequency scaling factor for the PPM so that the analog voltage coming in from the FREQUENCY INPUT connection can be interpreted to the correct frequency by the PPM's microprocessor.

User Supplied Cal Factor

Whenever you might prefer to use your own detector frequency response correction factors, the PPM provides a means to correct for any detector frequency response variations manually (in dB). An example where this could be necessary is when the data stored in the detector's PROM might be out of date.

To activate the Cal Factor feature of the system, press:

MENU (3) → F3 → F3

If the dual channel 8502A is being used, you will be asked to select a channel. Select A or B as appropriate.

Next, the value of the desired Cal Factor must be entered in dB. Complete the entry by pressing any Units key.

When using the Cal Factor mode, the frequency of operation is unknown to the PPM. Therefore, the Cal Factor will be shown on the EL display instead of Frequency. This also serves to notify you that this mode is in effect. The EL readout will display the Cal Factor as "CF = nn.nn dB."

NOTE: In the Cal Factor mode of operation the FREQ key is used to alter the Cal Factor (dB), not the frequency.

Offset

(Offsets data readings by a user selectable dB figure)

The Offset feature of the instrument is capable of digitally offsetting the displayed power value within a range of -40 to +90 dB. The offset will be in effect whether the measurement is in dBm or linear power in milliwatts.

The Offset function is mainly useful for two purposes. One is the ability to add or subtract minor correction factors to correct for possible errors that might be introduced by attenuators or other devices in the test setup. The other purpose is the ability to adjust the reading in high power measurement situations where it is desirable to read the correct power directly on the display despite the fact that the unattenuated power being tested is well above the measurement range of the detectors.

In the latter case, a high power coupler is normally used to attenuate the signal to a level that can be safely measured by the detectors (less than +20 dBm). If the exact coupling factor of the coupler being used is known, the Offset feature can then be used to subtract it out. Then the display will accurately show the high power present at the device under test. (However, the detectors only see the coupled power which has been attenuated to avoid burning out the detector diode.)

To offset the displayed power reading, press:

(8501A) MENU (3) → F1
or
(8502A) MENU (3) → F1 or F2

(F1 is for the Model 8502A channel A offset and F2 is for the channel B offset.)

After the Offset function has been selected, enter the desired offset in dB and then press ENTER.

When the Offset function has been activated, an asterisk (*) will appear next to the "FREQ" indication on the EL display to indicate to the operator that an offset is in use. (If the Cal Factor function is in use. the asterisk will be next to the "CF" indication.)

The display will appear as:

"*FREQ = nn.nGHz" or "*CF = n.nndB"

CW Power Measurement

To make a CW measurement be sure that the PPM has warmed up for at least 30 minutes, and then perform the following steps:

1. Select the CW Mode as described on page 3-7.

2. Self-Calibrate the PPM as shown on page 3-10.

3. Determine that the power range to be measured will not exceed the maximum power capability of the instrument (**must be less than +23 dBm**). If it will, connect an attenuator or coupler to the output of the device under test to bring the power down into the range of the PPM, and use the attenuator or coupler's output as the measurement point for the detector attachment. If in doubt, use a 10 dB attenuator. This should prevent a mild overload that might only result in detector degradation rather than burn out.

4. Be sure the RF power of the source is completely OFF.

5. Connect the detector to the power source being measured.

6. Auto-Zero the detector by pressing:

   MENU (1) → F3 → F2 → UNITS

   or, if channel B of a Model 8502A is to be zeroed:

   MENU (1) → F3 → F2 → CLEAR → UNITS

When a "chime" is heard, this indicates that a successful auto-zero has been accomplished. If a "warble" is heard, then either there was RF power present at the detector input or there could be a failure. (If a failure is suspected, then run the Self-Test procedure given on page 3-30.)

7. Upon successful completion of the auto-zero function, turn on the RF power of the source to be measured.

8. Take into account the detector's frequency response so that an accurate reading can be made at the frequency of operation. If the External Frequency mode (i.e. PROM Table and Sweeper Back Panel) is being used, this step is unnecessary. (See PROM Frequency Correction on page 3-11 for more information.) The keystrokes are as follows:

   FREQ → nn.nn → GHz

   If the PPM is in the "PROM Table - User Supplied Frequency" mode, nn.nn is the Carrier Frequency in GHz.

   If the PPM is in the "User Supplied Calibration Factor" mode, nn.nn is the Cal Factor in dB.

9. If a coupler or attenuator is being used at the detector input, enter the attenuation value as a positive offset. For example, if an attenuator with a value of 30.2 dB at the frequency of operation were being used, the required offset would be entered as follows:

(8501A) MENU (3) → F1
or
(8502A) MENU (3) → F1 or F2

(Select F1 for channel A, F2 for channel B)

Then enter the value of the offset in dB, followed by the dB Units key:

30.2 → dB

10. The PPM will now be reading CW power, and the display will look something like:

    A: +35.26 dBm

    **FREQ=10.78 GHz CW*

NOTE: +35.26 dBm represents the power at the input of the attenuator which is connected to the detector input. The actual power at the detector input would be +35.26 - 30.2 = +5.06 dBm.

11. Select the number of samples to be taken to arrive at an average reading (default is 4 readings):

    MENU (2) → F1

    Then enter the number desired followed by pressing any Units key.

    The number of samples that can be taken to arrive at an average can be between 1 and 999. For power levels below -30 dBm, it is recommended that more than 100 samples be taken to reduce noise effects.

12. To change the displayed power reading from dBm to milliwatts or vice versa, press:

    MENU (4) → F3

Peak Power Measurement

Method 1: Peak Mode via Graph Autoscale

There are several methods that can be used to make Peak Power measurements with the system. The easiest method is to use the Autoscaling function in the Graph Mode. The Autoscaling function only operates on pulses greater than the selected trigger level. Complex pulse shapes such as double pulses cannot always be successfully autoscaled. Methods for these situations will be covered later.

After the pulse to be measured has been successfully autoscaled, it is only necessary to press the PEAK key and the system will read the power at the center point of the pulse. The readout will be displayed on the EL screen in large alphanumeric characters. For the following procedure, assume that either a single channel Model 8501A is being used or just channel A or channel B of the dual channel 8502A.

AUTOSCALING PROCEDURE - Internal Trigger

1. Connect the detector(s) to the PPM and allow it to warm up for 30 minutes. Then conduct the Self-Cal procedure as described on page 3-10.

2. When Self-Cal has completed, connect the channel A (or B) detector input to a pulsed signal greater than -10 dBm (the default trigger level). Press the GRAPH key once to select the Graph Mode, and then a second time to start the Autoscaling function.

   When the Autoscaling function is initiated the PPM will change to internal triggering off of the displayed channel. Then it will attempt to automatically select the correct Window Delay time and Reference Power which will center the pulse on the display. The Start Delay will be set to zero. If the signal at the detector RF input is less than the trigger level (or there is no pulse present at the input), then the system will not trigger and the following display will appear:

   Waiting for trigger on A (or B) Detector Signal

F1 for Trig Mode or Level Change	*F3 for CW Data Display*

   If it is still desired to "Autoscale" at this point, the easiest thing to do is to increase the RF power until the power at the detector input is greater than the trigger level. Then the system will start to trigger and the autoscaling process will begin.

NOTE: The factory-set default initial delay is 75 µs (pulses wider than 75 µs or pulses less than 75 µs apart cannot be Autoscaled when using the default setting), and the default pulse averaging is four samples for the Autoscaling function. This can be changed to allow the user to enter a different pulse width and averaging number by accessing Menu #9 (press the MENU key 9 times), and then following the prompts given in that menu. Once the pulse width and/or pulse averaging has been changed from the default setting, the values will remain at the new setting whenever the instrument is turned off and on again. The values are not affected by recalling set-ups, or are they reset at power-on. (See Appendix D on page 3-45.)

3. If the previously mentioned triggering requirements have been met, the PPM will display the statement, "AUTOSCALING IN PROGRESS." When the Autoscaling has successfully completed, the pulse profile will be centered in the graphics display area on the left side of the EL readout window and the top of the pulse will line up with the 100% tic mark. The Cursor (displayed as a vertical line with spaces just above and below the point where it crosses the pulse) will be located at the center of the pulse profile. If all of the above has occured, you can go to the Power Display instructions given below.

Due to the many varieties of pulse widths, pulse shapes, and duty cycles that might be encountered, it is not always possible for the PPM to autoscale. If the failure to autoscale is the result of a pulse being present at the 75 µs default setting, the setting can be changed by accessing Menu #9, making the change, and then repeating the autoscaling procedure detailed in this section. It is necessary to keep the initial delay less than the time from the trigger to the start of the second pulse since the Autoscale routine cannot handle multiple pulses in the delay window.

AUTOSCALING PROCEDURE - External Trigger

When pulses are autoscaled on an external trigger, the PPM uses the internal trigger level of the selected detector to find the pulse. For this reason, the internal trigger level of the selected detector must be lower than the maximum power of the pulse. A good test is to first select internal trigger and verify that the PPM is triggering before trying external trigger autoscaling.

The external triggered autoscale will set the Start Delay to center the pulse in the delay window. However, autoscaling may not work properly if the pre-trigger is more than ten times the pulse width.

POWER DISPLAY

1. Press the PEAK key. The PPM will now display the power reading at the Cursor location in large alphanumeric characters, similar to the display shown above in Figure 3-2.

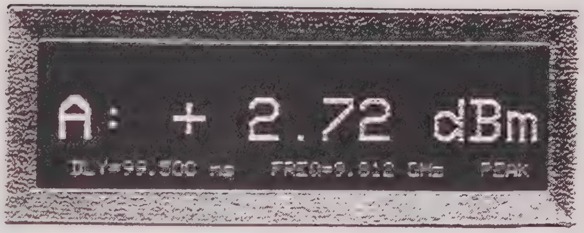


Figure 3-2. Typical Single Channel Peak Power Display

   At the lower left of the display will be the statement "DLY = n.nnn µs". This is the Cursor Delay which indicates the time difference between the pulse's initial triggering point and the point where the reading was taken. (If the triggering method is changed, a given Cursor Delay does not necessarily guarantee that the power reading will be taken at exactly the same point on the pulse as it was before.)

2. Press FREQ and enter either the RF operating frequency or the Cal Factor in dB.

   (This step is not required if the External Frequency input mode is being used.)

3. Enter any required offset as described on page 3-12.

4. If desired, the Peak Averaging can be changed by pressing:

   MENU (2) → F2 → nnn → any Units key

   (nnn = number of samples to be averaged - must be between 1 and 999. Default is 4)

5. The power will then appear on the display.

6. To change the time at which the power readings are taken, adjust the spin knob on the front panel.

   Alternatively, Delay entries can also be made through the keypad. After the desired numeric entry has been made, pressing the appropriate Units key will enter the delay in either ns, µs, or ms. Pressing any UNITS key without entering any numbers will cause the small delta symbol (Δ) next to the DLY indication on the screen ("Δ DLY = N.NN ns") to disappear. This indicates that the keypad and spin knob are inactive, and keeps the spin knob from being accidently bumped and moving the cursor to some undesired delay time. To reactivate the Delay time entry, press either the ↑ or ↓ key.

Method 2: Peak Mode - Direct Access

For the purposes of this procedure, assume that either the single channel 8501A or only channel A of the dual channel 8502A is being used. The procedures for channel B of the 8502A are almost the same as those for channel A. However, if it is desired to use the Internal Trigger function with channel B, this must be selected by using the MENU key as described in the Internal Triggering discussion on page 3-8.

1. Allow the PPM to warm up for 30 minutes, then conduct the Self Calibration procedure as described on page 3-10.

2. Select the Peak Power Mode of operation (page 3-8), being sure to observe the triggering guidelines. If there is no external trigger available or if there is any uncertainty as to which method to use, use the Internal Trigger.

3. To verify that the PPM is in the desired mode and that it is receiving the proper triggering, check the following:

    a) The light in the center of the PEAK key should be lit. (If not, this means that the Peak Mode has not been entered.)

    b) The "Ready" and "New Data" lights should be flashing. (If not, then the system is not receiving a trigger. If external was selected and no triggering indication is observed, try the Internal Trigger function. The RF pulse power level must be greater than -10 dBm.)

4. Once Step 3 has been successfully accomplished, the PPM should be taking readings in the Peak Power Mode. However, the cursor might not be positioned on the specific pulse of interest at this time.

The easiest way to ensure that all of the Peak Mode settings are at their default values is to select Peak operation after re-initializing the current setup. Press:

MEM (3) → F1 → PEAK.

The EL display of the PPM should look something like Figure 3-2.

An indication of "-------" instead of a number in the power readout portion of the display would indicate that the power being sampled is below the measurement range of the system. This means that either the overall power of the pulse is too low, or that the cursor has not been placed on a sufficiently high powered section of the pulse of interest. (Another possibility could be that there is no RF present at all. In that case, however, the PPM would not be triggering if Internal Triggering were being used and there was not enough RF at the detector input.)

NOTE: If the External Trigger mode is being used, the likelihood of obtaining a meaningful power reading at this point depends on the timing relationship between the RF pulse at the detector input and the external trigger pulse coming in through the rear panel input connection of the instrument.

If the trigger pulse and the RF pulse are coincident in time, then the default Cursor Delay time of 1 μs will probably result in the Cursor being located somewhere on the pulse. This depends, of course, on the pulse width exceeding 1 μs.

It is recommended that Internal Trigger is used before using the External Trigger mode so that certain pulse information such as pulse width can be obtained. This can save the effort of having to search for the pulse using the Cursor Delay function. (Using the Graph Mode makes searching much easier.)

5. As previously mentioned, the delta symbol (Δ) next to the DLY indication on the display means that the spin knob is active and, if turned, will alter the value of the Cursor Delay (CSR DLY). To locate the highest power point on the pulse, it is best to start at the rising edge of the pulse and move the cursor gradually up in time until the power reading reaches its maximum point. This can be done as follows:

    a) Turn the spin knob counter clockwise until the Cursor Delay is zero (i.e. "DLY = 0.000 ns" on the display).

    b) Slowly rotate the spin knob clockwise while monitoring the power readout display. Note that the increments that the spin knob causes the DLY to step through will change faster as the knob is turned faster. Rotate the knob until the power readings begin increasing. This indicates that the leading edge of the pulse being measured is being monitored.

c) Continue increasing the Cursor Delay until the power readings go through a peak or stay at a high level. If the maximum power point is passed, turn the knob counter-clockwise slowly, thus reducing the cursor delay until the maximum reading is once again reached.

d) Press the FREQ key and enter either the desired RF operating frequency or the Cal Factor in dB as required. (This step is not necessary if the external frequency input mode is in use.)

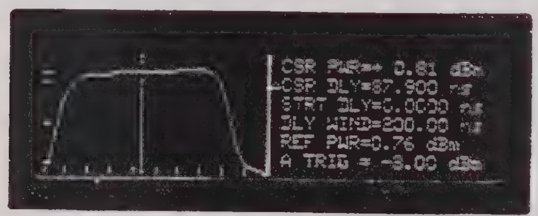
e) Enter any required dB Offset as described on page 3-12.

f) The power will be displayed similar to Figure 3-2 on page 3-15. The desired unit of power measurement can be selected by pressing the dB/mW key on the front panel.

6. If difficulties arise in locating the pulse to be measured, it is advisable to use the Graph Mode with Autoscale.

Peak Power Measurements Using The Graph Mode

It is recommended that the basic information pertaining to the Graph Mode given on page 3-9 be read for a better understanding of this function. The initial Graph Mode (Cursor sub-mode) display looks something like that shown in Figure 3-3. Pulse profiles are shown graphically on the left side of the display while the right side displays the power and timing parameters pertinent to the pulse.



```
CSR PWR=+ 0.81 dBm
CSR DLY=87.900 ns
STRT DLY=0.0000 ns
DLY WIND=200.00 ns
REF PWR=0.76 dBm
A TRIG = -3.00 dBm
```

Figure 3-3. Typical Initial Graph Mode Display

To use the Graph Mode for peak power measurements, follow the instructions given next for accessing the Graph Mode:

1. Connect the detector(s) to the detector connection(s) on the front panel, and allow the system to warm up for 30 minutes. Then conduct a Self Cal as described on page 3-10.

2. After ensuring that the pulse power of the RF source to be measured is not high enough to cause damage to the detectors (limit to less than +20 dBm), connect the channel A detector to the source.

3. Select the Graph Mode of operation by pressing the GRAPH key. Press the AUTOSCALE key and.the PPM will attempt to autoscale the pulse on the display. If there is no pulse present at the detector input or if the pulse power is below -10 dBm, then the PPM will not trigger (the "New Data" light will be out).

While the PPM is Autoscaling, the display will indicate "Autoscaling in Progress". When autoscaling is complete, the pulse will be centered in the graphics area of the EL display and the vertical cursor will be positioned at the center of the pulse profile.

If the display does not indicate a pulse centered in the graphics area of the EL display with the vertical cursor positioned at the center of the pulse profile, then the autoscaling process was not successful.

One possible reason that the PPM might not be able to autoscale is that the RF pulse might be too wide. The default setting of the PPM for the maximum pulse width that can be autoscaled is 75 µs. If desired, this maximum setting can be changed by accessing MENU (9) and then selecting F2.

Pulse, Cursor, and Marker Readouts

On the 8500A, the Graph display mode has been enhanced to 1) simplify entry of timebase, triggering, and display scaling (CURSOR sub-mode), 2) allow automatic readout of rise time, fall time, and pulse width (PULSE parameter sub-mode), and 3) allow automatic readout of time differences between custom marker settings on the pulse (MARKER sub-mode).

These three functions can all be accessed by pressing the PULSE/CURSOR/MARKER front panel key. Pressing the key cycles the right hand side of the display through the three sub-modes.

Cursor Sub-Mode Functions

The Cursor sub-mode is convenient for changing the timebase parameters of the display (the **CurSoR DeLaY**, the **STaRT DeLaY**, and the **DeLaY WIND**ow), the scaling of the display (the **REF**erence **P**o**W**e**R**), and the trigger level if the PPM is in internal trigger mode.

A. CSR PWR

Indicates the power level at the location of the cursor. By pressing MENU (4) → F3, this can be indicated in either dBm or in Watts. This is a readout only function, and cannot be changed with the spin knob or numeric entry keypad. Placing the Δ icon here will prevent an accidental movement of the spin knob from changing a parameter,

B. CSR DLY

The Cursor Delay indication shows the amount of time after triggering has occured that the Cursor will sample the power of the pulse. The time at which the trigger occurs is dependent on either the Trigger Level or, if External Triggering has been activated, on the triggering signal provided by the external source. The delta symbol next to CSR DLY means that the Cursor Delay is adjustable by using either the spin knob or the keypad. The delta symbol is placed by using the ↑ or ↓ key.

C. STRT DLY

This is the Start Delay of the graphics display area on the EL readout. It signifies the amount of time between the occurence of the trigger and when readings begin at the left side of the graphics display. If the default value is still set, then the Start Delay would be set to 0.0000 nanoseconds and the left edge of the display will be coincident with the timing of the trigger. However, the Start Delay may be at whatever value was used the last time the Graph Mode was accessed. The Δ icon next to STRT DLY means that the spin knob or keypad can be used to adjust the Start Delay value.

D. DLY WIND

The Delay Window is the amount of time between the left and right sides of the graphics display area. The default value is 10.000 µs. When the Autoscale function is used, the PPM will adjust the Delay Window to display the pulse profile so that the trailing edge of the pulse can be seen. Autoscaling will decrease the Delay Window in a 1, 2, 5 sequence as required until the trailing edge no longer disappears from view off of the right side of the graphics area. The Δ icon next to DLY WIND means that the spin knob or keypad can be used to adjust the Delay Window value.

E. REF PWR

The PPM's Reference Power nomenclature refers to the manner in which the pulse profile is displayed. Referring to the left hand graphics area of Figure 3-3 on page 3-17, there are four horizontal "tic" (division) marks on the left vertical axis of the display. These tic marks correspond from top to bottom to the 100%, 90%, 50%, and 10% power points on the pulse profile with respect to the Reference Power. The pulse profile is always displayed in linear units. The default Reference Power is 1 mW. However, once the Autoscale function has been used, the Reference Power is automatically adjusted to whatever the power level is at the middle of the pulse. Therefore, the Autoscale feature not only serves to center the pulse on the time (or horizontal) axis, it also optimizes the display positioning on the power (or vertical) axis by setting the highest power level as the 100% Reference point.

The adjustable Reference Power level is provided to give the user flexibility in displaying the pulse, and measuring pulse timing parameters using the markers. This is important because it means that the PPM can be set up to accommodate the various types of test parameters that different users might need for their specific measurement requirements.

NOTE: The reference power level is used as the 100% power level in the marker sub-mode, but is not used in the cursor or pulse parameter sub-modes. See the descriptions of marker sub-mode (page 3-20) and cursor sub-mode (page 3-17) for a more detailed explanation.

There are two ways to set the Reference Power Level on the PPM.

The first way is to move the Δ icon to the REF PWR (next to last) line of the displayed parameters (use the ↑ or ↓ key). Then, enter the desired Reference Power level and press the appropriate Units key (dBm for logrithmic units; mW, W or kW for linear units).

The second way is to move the Δ icon to the CSR DLY line and move the cursor to the point on the displayed pulse profile that is desired to be 100% reference. Next, move the Δ icon to the REF PWR line of the display. Then pressing any Units key will shift the pulse vertically on the screen, resulting in the selected point lining up with the 100% tic mark on the display.

Reference Power cannot be changed with the spin knob.

F. TRIGGER

This display indicates the present triggering mode of the PPM. "TRIG LEV = -10 dBm" ("A TRIG = -10 dBm" in the 8502A) is the default setting. It means that the PPM will trigger when the leading edge of the RF pulse rises above -10 dBm at the (channel A) detector input. "B TRIG =" (8502A only) indicates that the PPM is triggering off the channel B detector.

To change the Trigger Level, use either the ↑ or ↓ key to move the Δ icon beside the TRIG LEV indication. The spin knob can then be used to alter the Trigger Level, or a desired number can be entered through the keypad and terminated with the dBm or mW key.

"EXTERNAL" means that the PPM is triggering off the TTL trigger input on the back panel regardless of which channel is being displayed.

Selecting External Trigger or changing the internal trigger channel is accessed through MENU (1). See Triggering on page 3-8.

Pulse Parameters Sub-Mode Functions

Commonly used timing measurements required when analyzing pulsed RF/microwave signals are:

- Pulse Width
- Risetime
- Falltime
- Peak Power
- Repetition Rate

The pulse parameter readout allows the first four of these parameters to be measured directly by the PPM and displayed on the EL readout window. Auxiliary equipment may sometimes be required to measure repetition rate.

While in the GRAPH Mode, the Pulse sub-mode routine is entered by pressing the PULSE/CURSOR/MARKER key on the front panel.

Pulse Risetime, Width, and Falltime

The PPM displays the time between three pairs of start and stop power percentages. The default values for start and stop percentages are:

Measurement	Start%	Stop%
Rise time	10% rising edge	90% rising edge
Fall time	90% falling edge	10% falling edge
Pulse Width	50% rising edge	50% falling edge

These parameters can be set or changed as follows:

1. Press the PULSE/CURSOR/MARKER key to display the pulse parameters.
2. Move the Δ icon (using the ↑ or ↓ keys) to the Pulse Width line on the display. The current Start % setting will be displayed.
3.. The last line of the display will show the prompt: Enter Start %.
4. Enter the desired Start % setting through the numeric keypad.
5. Press UNITS
6. The Enter Start % indication will change to Enter End %.
7. Enter the desired End % value, and press UNITS

(Repeated pressing of any Units key will cause the display to toggle back and forth between the Start and End Percent values.)

8. To change the start and stop percentages for rise and fall times, move the Δ icon to the appropriate line and repeat Steps 3 through 7.

The relationship of 10% to 90% rise or fall time equals 2.198 time constants for a single pole circuit. Similarly, a 10% to 90% power rise or fall time equals 1.098 time constants.

For some applications it is desirable to measure rise, fall, and width in terms of the voltage waveform instead of the power waveform. This can be done by simply modifying the appropriate start and stop percentages. The power waveform is proportional to the square of the voltage waveform. Therefore, to measure the voltage pulse parameters you would change the default percentages to the following:

Measurement	Start%	Stop%
Rise time	1% rising edge	81% rising edge
Fall time	81% falling edge	1% falling edge
Width	25% rising edge	25% falling edge

The pulse rise time, fall time, and width are displayed with the appropriate time units. A display consisting of all dashes "------------" indicates that:

a) The instrument failed to find the peak power point, or

b) The instrument failed to find a start percentage point, or

c) The instrument failed to find a stop percentage point.

The method used to find pulse parameters is as follows. On each trace sweep, the instrument:

1) Finds the 100% pulse level. Starting from the trailing edge of the pulse, the instrument looks earlier and finds the largest flat section (± 1 pixel on the screen) on the top of the pulse. This level is chosen as the 100% level. If no area is flat, (such as with gaussian shaped pulses) the maximum level found is used as the 100% level. This algorithm is used to help ignore the ringing and overshoot that sometimes accompanies rectangular pulses. Note that the display scaling (i.e., the REFerence PoWeR) is not reset and is independent of the 100% level found in this step.

2) Finds rise time, fall time and width. In order to improve the accuracy of timing measurements, you should set the delay window so that the pulse fills at least 20% of the screen.

Marker Sub-Mode Functions

The Marker sub-mode is another completely independent way to read the time difference between user defined points on the pulse waveform. It may, at first, seem redundant with the Pulse parameter mode. The Marker sub-mode, however, treats the 100% power point differently, and reads the differences between four user-defined points on the waveform. It is intended for use in specialized applications (such as measuring the linearity of the leading edge skirt of a navigation pulse) where the user is interested in other than standard rise, fall, and width measurements. This Marker sub-mode is also most similar to the Marker Mode offered in the original 8500 Peak Power Meter.

The Marker sub-mode uses the user-set REFerence PoWeR as the 100% power point of the pulse. This allows the user to set the 100% point at other than the flat spot at the top of the pulse. For instance, the 100% point can be set at the top of the pulse overshoot. The 100% point can also be set 10 dB lower than the top of the pulse to scale all the user-set marker percentages by 1/10. This is particulary useful to set marker percentages to resolutions better than 0.1% of the peak power.

The default settings for marker sub-mode are set for the measurement of linearity on the leading edge of a navigation pulse. In this particular measurement, the time between the 5%, 13.3%, 21.7%, and 30% points on the *voltage* waveform are compared. Equal times indicate a linear voltage waveform between the 5% and 30% point on the waveform. Because markers are entered in terms of % power, the corresponding *power* percentages would be 0.25%, 1.78%, 4.69%, and 9.00%. Because markers can only be entered to 0.1% resolution, the actual marker values are set 10 times greater or 2.5%, 17.8%, 46.9% and 90.0%. Then, to get the maximum resolution from the markers, the REFerence PoWeR is set to exactly 10 dB less than the peak power of the pulse - effectively scaling all marker values by 1/10. (This action must be done manually.)

To change a marker percentage setting:

1) In GRAPH mode, press the PULSE/CURSOR/MARKER key until you see a display on the right side of the screen similar to:

Δ CSR PWR = +0.91 dBm
MKR 2 - 1 = 4.9000 ns
MKR 3 - 2 = 5.4000 ns
MKR 4 - 3 = 10.5000 ns

2) Move the Δ icon (using the ↑ or ↓ keys) to the MKR 2-1= line on the display. The current marker percentage setting for marker 1 will be displayed.

3) Enter the desired Marker 1 percentage through the numeric keypad, using any Units key to terminate the entry.

4) Repeat steps 2 and 3 at the MKR 3-2 = line to change the Marker 2 percentage, and the MKR 4-3 = line to change the Marker 3 percentage. To change the Marker 4 percentage, move the (Δ) icon to the blank line just below the MKR 4-3 = line.

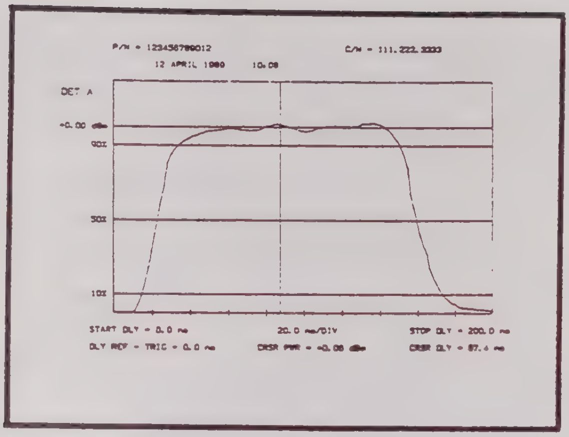


Figure 3-4. Typical Cursor Sub-Mode Digital Plot

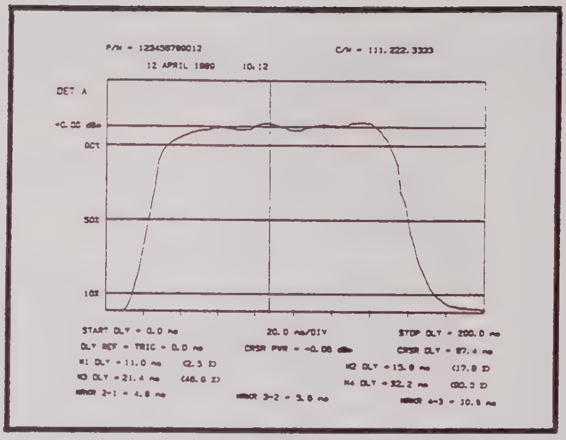


Figure 3-5. Typical Marker Sub-Mode Digital Plot

Digital Plotting of Graphic Data

Plotters Supported

The PPM is configured to provide direct output of Graph Mode information for hardcopy recording on a digital plotter. This is done without the necessity of using a computor or GPIB controller. The following plotters (and any other 100% compatible plotters) are supported:

- Hewlett-Packard Model 7440A
- Hewlett-Packard Model 7470A
- Hewlett-Packard Model 7475A

All of the above plotters must be configured with the option for GPIB usage.

Procedure for Making Plots

The procedure for making plots with the PPM is quite simple. Plots can be made when in the Graph Mode and Marker sub-mode, and the plots will be essentially duplications of the information shown on the PPM display at the time the plot function is activated.

Two different plotting speeds can be selected by the PPM. These are: a Fast Plot for use with normal plotting paper, and a Slow Plot for making plots using transparence paper (film).

To make a (fast) paper plot, press:

MENU (2) → F3 → F1

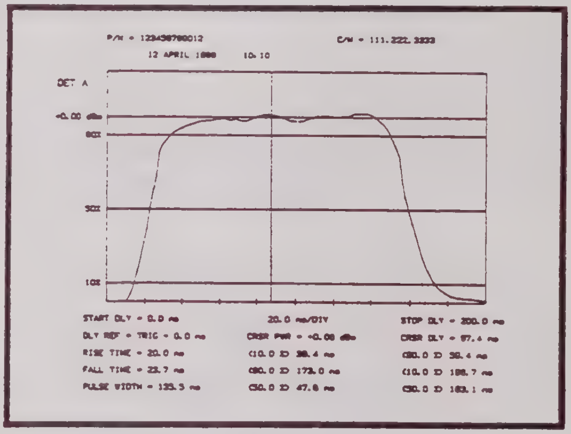


Figure 3-6. Typical Pulse Sub-Mode Digital Plot

To make a (slow) transparency plot, press:

MENU (2) → F3 → F2

It should be noted that when the PPM has "drawn" a complete pulse profile on its display, it is ready to act as a GPIB controller. If the PPM is part of a GPIB system, **it is up to the user to be sure that no front panel plot function is initiated to ensure correct operation of the system.**

The following steps are required to generate an X-Y hardcopy plot:

1. Connect a GPIB cable from the PPM's rear panel GPIB connection to the plotter's GPIB input connection.

2. Choose a GPIB address for the plotter, and set its address switches according to the instructions in its operating manual. (Address 6 is recommended; see Step 3.)

3. Select the plotter address for the PPM by pressing:

   MENU (6) → F2 → nn → UNITS

   Where "nn" is the plotter address. The default address to which the PPM sends data is 6. If the plotter address is changed from the default value of 6, it will remain at the new value until another value is entered. That is, it is not reset at power-on or any other time until intentionally changed again.

4. Check that the plotter pens are installed and operating properly. Following the manufacturer's instructions, insert paper into the plotter and prepare it to plot.

5. If it is required or desired, enter a Code number or Part number to be printed on the plot. If no Code and Part numbers are selected, numbers previously entered will be plotted. The default numbers are blank.

   a) Enter the Code number as follows:

      MENU (5) → F1 → nnnn.... → UNITS

      (Where nnnn.... is a number up to 12 digits.)

   b) Enter the Part number as follows:

      MENU (5) → F2 → nnnn.... → UNITS

      (Where nnnn.... is a number up to 12 digits.)

6. The date and time are always plotted. The date and time are obtained from the internal, real-time clock of the PPM which is kept alive by a battery when the instrument is turned off. If it is desired to check and/or change the date and time before plotting, press:

   MENU (5) → F3 → F3 (if clock is correct)
   or, to change the clock:

   MENU (5) → F3 → F1 → mmddyy →
   UNITS → hhmmss → UNITS → F3

   (mmddyy = month, day, year)
   (hhmmss = hours, minutes, seconds)

7. Enter the Graph Mode. The Delay Difference Timing will be plotted if it has been activated on the EL readout. See Figures 3-4, 3-5, and 3-6 on page 3-21 for examples of the types of plots available from the PPM.

8. Before the PPM can make a plot, it must first complete one "sweep" of the pulse profile. Assuming the profile is completed, press:

   MENU (2) → F3 → F1 for a paper plot
   or
   MENU (2) → F3 → F2 for a transparency plot

If there is any GPIB bus error, an alarm will sound. This indicates that when the PPM checked the IEEE Bus, it was unable to address the plotter. The possible causes for this might be an incorrect address setting, the plotter not set up correctly, or the plotter is turned off. If this situation occurs, press F2 to return the PPM to its previous mode of operation. (Note: This feature allows PPM operation to continue despite bus "hang-ups".)

9. Once the plot has started, control of the PPM can be regained before the plot has finished. This gives the ability to proceed with further testing without having to wait for the plotter to complete its task.

10. If it is necessary to Abort the plot for some reason, press:

    MENU (6) → F1

The plot will be terminated as soon as possible.

Dual Channel Measurements

(Model 8502A Only)

The dual channel capability of the Model 8502A provides two very useful functions. These are:

- Display of Power Measured by Two Channels Simultaneously.
- Display of the Power Ratio between Two Channels.

Applications for these two functions are many and varied. Dual channel measurements allow two points in a system to be measured with one power meter. The PPM can simultaneously measure both channels in either the CW or Peak Power Modes.

The Ratio function allows relative measurements to be made in either CW or Peak. It is also possible to ratio Peak to CW or CW to Peak. These functions are useful for gain and loss measurements under CW or Peak conditions (or a combination of the two).

Dual Channel Operation - CW, CW Measurements

The following procedure is used for making dual channel CW measurements:

1. After power-on, press CW to access the CW Mode. [Press MEM (3) → F1 to have the PPM use its default values, if desired.) Wait for approximately 30 minutes for the PPM to warm up.

2. Self-Calibrate both channels. Press:

   MENU (1) → F3 → F1

   Follow the instructions displayed by the PPM, connecting the appropriate detector to the Calibrator when prompted.

3. Connect the detectors to the device(s) or system to be tested.

4. The PPM will now be displaying CW power for channel A. To display CW power for both channels, press B.

5. Select the frequency of operation or cal factor as necessary for detector response correction by pressing the FREQ key. (For information on frequency correction, see page 3-11.)

6. Enter any required display offsets. (See page 3-12 for more information.)

7. To return to single channel operation, use the DETECTOR SELECT A and B keys as required.

Dual Channel Operation - Peak, Peak Measurements: Method 1

1. Follow the procedure given in Dual Channel Operation - CW, CW Measurements, except press the PEAK key in Step 1 instead of the CW key.

2. If the PPM is triggering, it will then display the Peak power in both channels. The following default settings are in effect if the PPM has been re-initialized.

   - Internal Trigger from channel A set at -10 dBm (i.e. pulse at channel A causes trigger if greater than -10 dBm)
   - Frequency = 1.00 GHz
   - Chan A Cursor Delay = 1.0000 µs
   - Chan B Cursor Delay = 1.0000 µs
   - Spin knob active on channel A Cursor Delay as indicated by " Δ " next to CSR DLY

3. If the PPM's "New Data" and "Ready" lights are flashing, this means that a trigger is occuring and measuring should be possible. Try adjusting the channel A Cursor Delay by turning the spin knob until the CSR DLY reads 0.0000 ns. The Delay can then be increased slowly until the reading is being taken on the desired part of the pulse.

4. To change the Cursor Delay for channel B, press the ↑ or ↓ key. The spin knob can then be used to alter the channel B Cursor Delay. To lock out the spin knob and keybaord, press any UNITS key. To reactivate the spin knob and keyboard, press the ↑ or ↓ key.

5. If there are any difficulties due to timing factors, it is recommended that External Triggering be used. The trigger signal should occur slightly before the RF pulses to be measured. The Cursor Delays can then be used to place the Cursors on the pulses to allow readings to be taken.

Dual Channel Operation - Peak, Peak Measurements: Method 2

This method utilizes the PPM's Graph Mode capabilities to facilitate placing Cursors on the pulses of interest. Signal timing should be considered first of all. For purposes of discussion, assume the timing of the signals to be measured are similar to those shown in Figure 3-7 on the next page.

As can be seen from Figure 3-7, the Measurement Port 1 pulse occurs before the Measurement Port 2 pulse. If Measurement Port 2 were used to generate an Internal Trigger, it would be impossible to set the Cursor on the leading edge of the displayed Measurement Port 1 pulse because the minimum Cursor Delay of 0 ns would be the trigger point (leading edge of the Measurement Port 2 pulse).

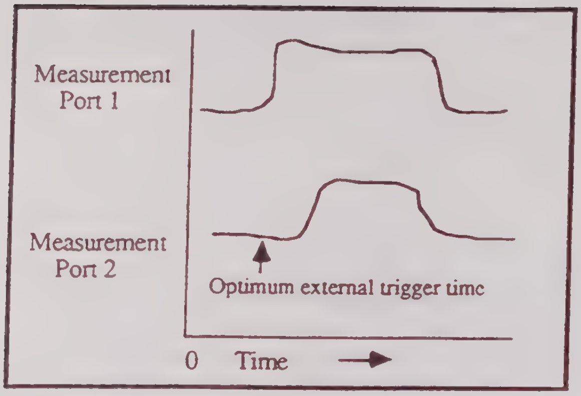


Figure 3-7. Typical Signal Timing

Therefore, this situation would require that either Measurement Port 1 be used to generate an Internal Trigger, or that an External Trigger be used. Doing this would ensure that readings could be taken at any desired points on the pulses being measured.

In cases where the pulses at each detector input are essentially occuring at the same time, this problem could be ignored. However, it is generally the case that using the External Trigger results in more satisfactory performance.

The preceding information is provided mainly to emphasize the importance of knowing the timing relationships of the signals to be measured. If there is any doubt or confusion, the rear panel MONITOR OUTPUT of the PPM can be connected to an oscilloscope to quickly ascertain the timing relationships.

Assuming an Autoscalable pulse greater than the current trigger level is to be measured by channel A for this example, the procedure for Dual Channel operation in the Peak Mode via the Graph Mode would be:

1. Connect the channel A detector to the RF source (port) that is believed to be generating a pulse before the second source (port) to be measured (i.e Measurement Port 1). If the pulses of the two sources are coincident, use either port.
2. Connect the channel B detector to the second source (port).
3. Select the Graph Mode in channel A, and press the GRAPH key to Autoscale.
4. After the pulse has been successfully Autoscaled, set the Cursor to the desired measurement point.
5. Make a note of the Window and Cursor Delays. (The Start Delay will be 0.0000 ns after Autoscaling.)
6. Press the DETECTOR SELECT B key to switch to the channel B Graph Mode.
7. Set the Window and Cursor Delays to the same values as were noted in Step 5. If the pulse is not visible on the EL readout, gradually increase the Start Delay until the entire pulse is on the screen.
8. Set the Cursor Delay to the point on the pulse where it is desired to take a measurement. Channel A and B Cursors should now be placed wherever dual channel readings are to be taken. This can be verified by pressing DETECTOR SELECT A or B as necessary to check that the Cursors are properly positioned.
9. Select the Peak Mode of operation by pressing the PEAK key.
10. Select Dual Channel operation by pressing DETECTOR SELECT A. Make sure that the LEDs in the center of the DETECTOR SELECT A and B keys are lit. This signifies that the PPM is in the Dual Channel Mode. The display should look something like:

```
A:   +0.65 dBm      30.600 ns
B:   -4.65 dBm      39.700 ns

FREQ = 1.00 GHz        PEAK
```

Power Ratio Measurement Procedures

To make Ratio measurements, the power measured by both channels must be within the specified power measurement range of the PPM system. When operating in CW, this power range is -40 to +20 dBm. In the Peak Mode, this power range is -20 to +20 dBm. Power readings taken in the Ratio Mode outside of these ranges will result in an error display.

The Ratio Mode only provides the ratio of A/B, not vice versa. The PPM can ratio two CW signals, two Peak signals, or a combination of both. The following procedures show how to perform each of these ratioing operations.

RATIOING TWO CW SIGNALS

This is the easiest Ratio function of the PPM. Proceed as follows:

1. Allow the PPM to warm up for at least 30 minutes. Then Self-Calibrate both channels. From power-on, press:

   CW → MENU (1) → F3 → F1

   Then follow the displayed prompts to complete the Self-Cal. After Self-Cal has completed, the PPM will be measuring CW power in channel A.

2. Select the Ratio Display Mode by pressing:

   MENU (7) → F2

3. The default mode for power ratio measurements is for Peak power on both channels. To set both channels for CW operation, press:

   A → F2 → B → F2

The PPM will now be reading the ratio of A/B. Normally this is expressed in dB, however, it can also be expressed as a linear reading (such as 19654 EXP=-4) by pressing the dB/mW key. The EL readout screen indicates that two CW signals are being ratioed by displaying "CW/CW" in the lower right hand corner of the readout.

Remember that the frequency of operation or Cal Factor must be entered using the FREQ key, and any desired Offsets should also be included. (These functions are described on page 3-12.)

RATIOING TWO PEAK SIGNALS

The point in time at which readings of Peak power are taken in both channels for ratioing purposes is determined by the setting of the Cursor Delay. Although it is most desireable that both pulses being monitored occur at exactly the same time, in practice this would be a very rare event. Therefore, the signals to be measured must be carefully evaluated to ensure that accurate readings are taken.

The Cursor Delay must be set so that samples are being taken on both the channel A and B pulses. See Figure 3-9 for an example of good and bad Cursor Delay settings in this situation.

The following are guidelines that can be used when ratioing two Peak signals:

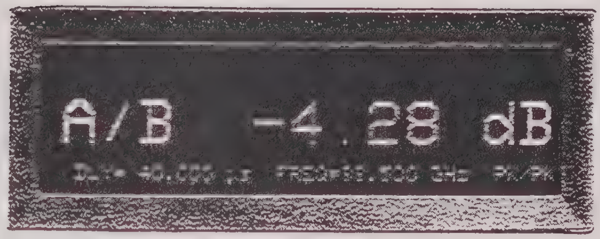


Figure 3-8. Typical Peak Power Ratio Display

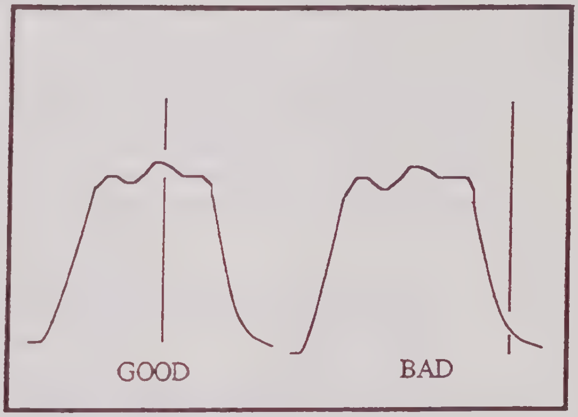


Figure 3-9. Typical Good & Bad Cursor Display Settings

1. Make a single channel Peak measurement using the Graph Mode (Autoscaling is recommended).

2. Set the Cursor Delay so that the power reading (CSR PWR) is being taken close to the center of the pulse.

3. Verify that the Cursor Delay setting is adequate for both channels by switching to the other channel. Use the same Start, Window, and Cursor Delays as in the first channel. If the pulses occured at the same time, the Cursor would be close to the center of the pulse sampled by the other channel.

4. Switch channels, checking to be sure that the Cursor is not placed close to the edge of either of the pulses being sampled.

5. Once the Cursor has been satisfactorily set, to activate the Ratio Display Mode press:

   MENU (7) → F2

The default setting for the type of signal being used by both channels is Peak. This is verified by "PK/PK" being displayed in the lower right hand corner of the EL readout. If this is not the case, select Peak operation by pressing:

A → F1 → B → F1

The PPM should now be displaying the Ratio of the two pulses. Be sure to use the FREQ key and Offset function if necessary.

RATIOING PEAK TO CW SIGNALS

This function is very useful in many applications such as traveling wave tube (TWT) testing that require the measurement of gain under pulsed conditions. This could be a problem when the TWT has a CW input and a pulsed output. The PPM easily performs this type of measurement using the following procedure:

1. Make a single channel Peak power measurement at the port of the device under test that has the pulsed signal.

2. Set the Cursor at the desired point on the displayed pulse profile. Using the Graph Mode is the simplest way to do this.

3. Select the Ratio Mode by pressing:

   MENU (7) → F2

4. Set which channel will be CW by pressing:

   B → F2 (if channel B is to be CW)
   or
   A → F2 (if channel A is to be CW)

5. Set which channel is to be Peak by following the same procedure as above, only pressing F1 instead of F2.

The lower right hand corner of the EL readout will indicate which channel is CW and which is PEAK. Whichever indication is farthest to the right side will be channel B.

DUAL CHANNEL OPERATION - PEAK, CW MEASUREMENTS

If it is desired to measure Peak power on one channel and CW on the other channel, the procedure is the same as when measuring Peak power on both channels with some minor differences. These differences are:

A. The channel used to make the Peak power measurement determines the triggering of the PPM. For low amplitude signals (below -20 dBm in the Peak Mode), use external triggering.

B. It is not necessary to use the Graph Mode or any Delay settings on the channel that will be measuring CW as the power will be continuous, and it makes no difference at what time the CW is sampled.

C. Even though one channel is displaying CW power, the PPM operates as though both channels were in the Peak Mode. CW averaging has no effect on the reading. The rate at which the RF is sampled and averaged is determined by the characteristics of the Peak power channel.

High Power Measurements

One of the most important things to remember when using the PPM is that it employs balanced, zero bias, Schottky diode detectors as power sensors. Due to this highly sensitive, highly accurate configuration, the maximum power that the detectors can handle before burning out is +23 dBm (200 mW). This limitation is regardless of duty cycle.

Power Warning - Max/Min Power Limits

The PPM has a built-in warning system to advise you of mild overloads to the detectors. Large overloads which are usually the result of a failure in the device under test or leaving an attenuator out of the test setup, cannot be prevented because of the speed at which these failures happen. However, you will be advised by a prompt on the EL display when the power level exceeds the preset power warning level.

The default value for the MAX Power warning point is +20.5 dBm. You can set this to anywhere between -10 and +21 dBm.

The PPM also has a lower level limit (MIN). This is mainly used to avoid displaying power readings outside the lower power range of the instrument. When the power level being measured by the PPM is below the lower level limit, the EL readout will display dashes (--------) to indicate that the power being measured is too low for the PPM to take an accurate measurement.

The default value for the MIN Power warning point is -45.0 dBm. You can set this anywhere between -15 and -50 dBm.

To change the MAX and MIN power limits, press the following keys:

MENU (7) → F1 → mm.mm → dBm → nn.nn → dBm

Where mm.mm is the Maximum power limit, and nn.nn is the Minimum power limit.

High Power Measurement Procedures

The procedure for making absolute CW or Peak power measurements under high power conditions is as follows:

1. Approximate the Peak power of the signal to be measured.

2. After 30 minutes warm-up, Self-Cal the PPM detectors.

3. Choose an appropriate attenuator or coupler to be used in the test setup to reduce the power being measured to a safe level for the detectors. **The power at the detector input must be less than +20 dBm.**

When making this approximation, be sure to use "worst case" power levels. If in doubt, a 10 dB attenuator can be used directly on the detector input in addition to the selected high power coupler or attenuator.

4. Ensure that the RF power of the source to be measured is turned OFF.

5. Connect the high power coupler to the RF source to be measured as shown in Figure 3-10. If a high power attenuator is used, connect as shown in Figure 3-11.

6. Connect the PPM detector with its attenuator to the coupled output of the high power coupler (Figure 3-10), or to the output of the high power attenuator (Figure 3-11).

7. Auto Zero the PPM by pressing:

MENU (1) → F3 → F2 → UNITS

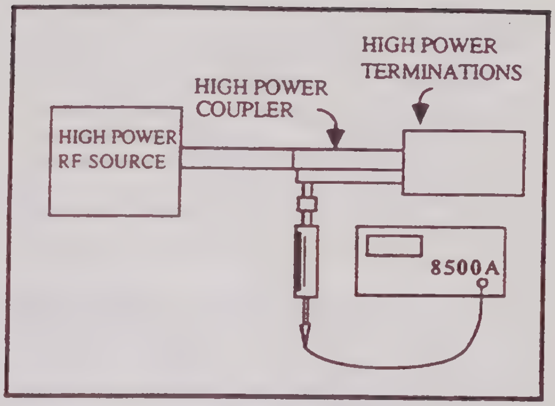


Figure 3-10. Detector Connection to a High Power Coupler

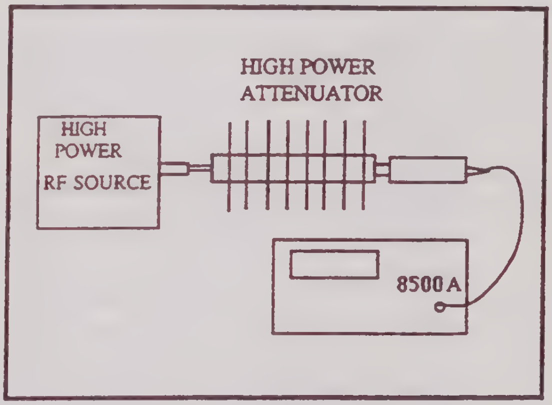


Figure 3-11. Detector Connection to a High Power Attenuator

If a dual channel Model 8502A is being used, follow the prompts given on the EL display readout. Select any Units key or CLEAR as necessary to Zero the desired channel(s).

8. Turn ON the RF power of the source under test.

9. If measuring a pulsed signal, it is important that the Cursor be placed on the pulse. This can be done by using the PPM's Autoscale feature which is activated in the Graph Mode by pressing the AUTOSCALE key. If this method is not possible, try using the Internal Trigger with the level set at -20 dBm. Then set the Cursor at 0.0000 ns and increase the Cursor Delay gradually until the CRS PWR is at its maximum.

If the "New Data" light on the front panel of the PPM does not flash, then the instrument is not triggering. If the trigger level is at -20 dBm and no trigger occurs, there might not be enough power at the detector input to be able to measure. If this is the case, recheck the calculations that were made to decide what attenuation levels were required to prevent detector burnout. If necessary, reduce the attenuation at the detector input by 10 dB to increase the power so that the PPM will trigger.

NOTE: If a TTL Trigger signal is available from the source being measured, then using the External Trigger Mode is advisable. If an oscilloscope is available, the PPM's rear panel MONITOR OUTPUT(s) can be used to determine the proper timing settings for the instrument.

10. Once the PPM is reading power as desired, enter the frequency of operation (or Cal Factor) by pressing the FREQ key.

11. To obtain the absolute power output of the RF source being measured, use the PPM's Offset feature to offset the displayed values by the combined attenuation values of the coupler and/or attenuators being used in series with the detectors. Most couplers and attenuators have attenuation versus frequency response curves supplied that can be used for exact entry of the required offset. To enter the Offset, press:

    MENU (3) → F1 → nn.nn → dBm

    Where "nn.nn" is the Offset desired. For channel B offset on the 8502A, use F2 instead of F1. When the Offset feature is in use, this will be shown on the EL display by the presence of an asterisk (*) next to the FREQ or CF indication.

HIGH POWER RELATIVE MEASUREMENTS
(8502A only)

The procedure for making a gain or loss measurement is the same as for absolute power, but requires activating the Ratio Display function of the 8502A. The Offset feature is used to compensate for external devices before entering the Ratio Mode. (See Power Ratio Measurement Procedures on page 3-24 for more information on Ratioing.)

Special Capabilities of the PPM

Reference Delay

To facilitate making timing measurements relative to some event other than the trigger (such as the falling edge of a pulse), it is possible to shift the PPMs time coordinates by using Reference Delay. The PPM subtracts the Reference Delay from the Cursor Delay and Start Delay, in effect shifting the zero time reference from the trigger time to a time after the trigger by the amount of the Reference Delay. To set the Reference Delay press:

MENU (4) → F1 (for Ch A or F2 for Ch B of the 8502A) → nn.nn → UNITS

Single Pulse Measurements

Measurement of a single pulse can be done with the PPM by operating in the Peak Mode. (The Graph Mode cannot be used for single pulse measuring.)

Two methods are available for making single pulse power measurements. These are discussed in the next two sub-sections.

Single Pulse Measurement Using Internal Trigger

To make a single pulse measurement using the Internal Trigger, it must first be decided how long after the trigger has occured that the measurement should be taken. For example, in the single pulse shown in Figure 3-12, the PPM trigger level is set to -10 dBm. If the Cursor Delay were set to 0.0000 ns, then the power measurement would be taken at the trigger point. In this case, this is not on the "top" of the pulse being measured.

In order to measure power at the top of the pulse as is required in most applications, the Cursor Delay needs to be set at around 5 µs. Therefore, to accurately make Peak power measurements using the Internal Trigger mode of operation, the operator must have some idea of the pulse width boundaries to be tested.

In cases where the risetime of the pulse is known to be repeatable and the pulse width is known never to be below, say, 8 µs, it could be decided to set the Cursor Delay to 5 µs. This decision would allow

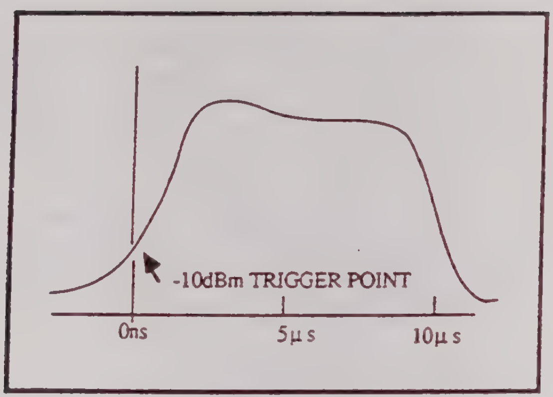


Figure 3-12. Single Pulse with -10 dBm Trigger Level

measurement of all pulse widths greater than 5 µs without the necessity of altering the Cursor Delay.

Single pulse measurements cannot be made with the same accuracy as repeating pulse trains. This is primarily due to the fact that there is no way to eliminate noise that might be present in the test setup. For repetitive pulse trains, averaging can be used to eliminate errors due to noise.

The procedure for making a single pulse measurement is as follows:

1. Allow the PPM to warm up for 30 minutes, then conduct a Self-Cal.
2. Select the Peak Mode of operation. If there is no pulse at the detector input there will be no trigger. If this is the case, the EL display will either be blank or frozen with the last data that was taken. The "Ready" light should be lit, the "New Data" light will be dark.
3. Set the Trigger Mode to Internal, and then set the trigger level as desired.
4. Set the Cursor Delay to the desired time following the trigger that the measurement is to be taken. Press GRAPH. Move the Δ icon to CSR DLY. Enter the desired delay (for this example, use 5 µs) through the keypad, and terminate with the ms, ms, or ns key. Then press PEAK.
5. Set the Peak Pulse Averaging number to 1.
6. Connect the detector to the RF source to be measured.
7. When a pulse of sufficient amplitude to cause a trigger enters the detector input, the PPM (in this case) will take a reading 5 µs later. The Peak power being measured at the time of the Cursor Delay will then be "frozen" on the display until the next pulse or trigger occurs.

Single Pulse Measurement With An External Trigger

Making a single pulse measurement using an External Trigger is done with the same limitations as with the Internal Trigger. However, it is possible to control exactly when the power reading is taken by supplying a TTL trigger to the PPM's rear panel trigger input at the appropriate time.

The PPM is set to External Trigger by pressing:

MENU (1) → F2

The trigger signal must arrive coincident with or before the RF pulse to be measured when measuring with the External Trigger. If the power reading needs to be taken exactly at the time that the trigger occurs, then the Cursor Delay is set to 0.0000 ns. If the pulse to be measured arrives after the trigger, then set the Cursor Delay so that the power reading will be taken at the desired point on the pulse.

Measuring Peak Power Under Swept Conditions

(See Figure 3-13 for typical setup)

The frequency response and power level characteristics of pulsed signals can be measured under swept frequency conditions by combining the capabilities of the Wavetek PPM with those of the Wavetek Model 8003, 1038-NS20 or Model 1038-N10 Scalar Network Analyzers.

The Analyzer's normalization memory can be used to subtract out "residual" test setup responses, thus allowing direct readout of the frequency response of the device under test. There are a variety of applications where this ability can be very useful such as:

- Pulsed TWT testing
- Microwave frequency performance of pulsed radar systems
- Return Loss

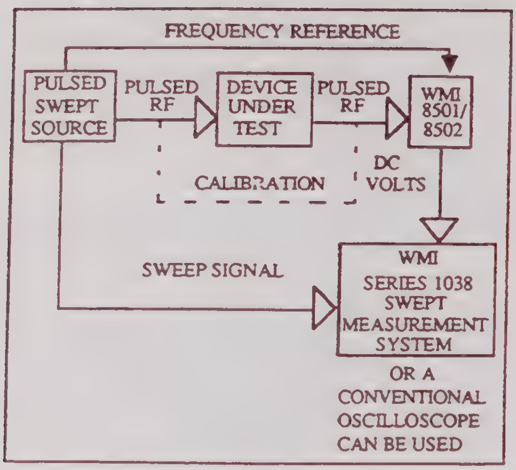


Figure 3-13. Typical Pulsed Swept Measurement System

- VSWR Measurements under Pulsed Conditions
- and others.

If a Wavetek Scalar Analyzer system is not available, a conventional oscilloscope can be used by first displaying the PPM's output, and then marking the system tracking errors on the CRT in grease pencil for visual correction.

The PPM is normally used in the Peak Mode for this type of testing. Most PPM settings would be the same as when measuring a single frequency pulsed signal. In order to use the Swept/ Pulse system with any degree of accuracy, the pulse repetition rate must be considerably faster than the speed at which the RF sweep takes place. This is determined mostly by the setting of the sweep generator's sweep speed.

The PPM is capable of reading better than 100 pps, and the output level will be at 100 mV/dB. Swept measurements can also be made simultaneously from channels A and B of the 8502A, but the PPM's reading rate will be somewhat slower.

It is very convenient to use the sweep generator's Frequency Reference signal to continually inform the PPM as to what the RF frequency is at any given time. (Frequency Reference is synonymous with V/ GHz, Voltage ∝ Frequency, etc.) Using this feature ensures that, as the sweep generator changes frequency, the PPM "knows" to alter its frequency correction accordingly. The PPM then uses the proper frequency correction for the detector(s) at each descrete frequency point without necessitating any operator input or any calculations. ("PROM FREQUENCY CORRECTION - External Frequency Input" on page 3-12 will give more information on the interfacing of external frequency signals.)

To make swept frequency measurements under pulsed conditions, equipment should be set up similar to Figure 3-13. The measurement routine is initiated by pressing:

MENU (10) → F1

During the time that the fast analog output mode is active, the PPM's EL display window will indicate:

FAST ANALOG OUTPUT
MEASUREMENT MODE

Press MENU key to exit

Self-Testing the PPM

[Prior to performing a Self Test during a testing routine (at some point after the instrument has been turned on), the detector must either be connected to the CALIBRATOR OUTPUT connection on the front panel, to a "50 ohm Termination", or to a "Signal Source" which has the RF power turned OFF.]

The Self-Testing feature of the PPM is provided as a quick "health check" of the instrument. The PPM performs a Self Test each time it is powered on. To initiate the Self-Test function at other times:

First remove all RF power from the detector. Then press:

MENU (11) → F2.

While the Self-Test is in progress, the following will be displayed:

PERFORMING SELF TEST
CLOCK/CALENDER INDICATES
(day) (date) (time) (year)
System version # = n.nn

At the successful completion of the Self-Test, the PPM will display "Self Test Completed: Passed". A "chime" will then be sounded, and the PPM will return to its previous display mode.

Table 3-A. Self-Test Error Flags

Error	Cause
01	-5.2V Supply
02	Memory Bad
03	Excessive A Channel Offset
04	A Channel Gain Error
05	Excessive B Channel Offset
06	B Channel Gain Error
07	A Channel Analog Output DAC
08	B Channel Analog Output DAC
09	Delay 8255s (ICs)
10	Delay Time Error
11	Calibrator Bridge Voltage Error

If some type of failure is detected by the PPM's microprocessor during the Self-Test, the display will indicate:

> *SELF TEST FAILED! - PRESS CLEAR*
> *ERROR NUMBER(S): 11, 8, etc.*

Pressing CLEAR will bring back the display of the last setup before Self Test. However a failed Self-Test indicates a problem of some kind, and it is recommended that the PPM not be used for measuring until it is checked according to the procedures given on page 7-12 of the Maintenance chapter of this manual. Table 3-A, above, gives a listing of the error numbers and their associated meanings.

Frequency Display Disable/Enable

If there is some reason (such as classified testing) why it might be desired not to have the frequency of operation displayed in the EL display window while measurements are being taken, this can be done by using the F3 key of MENU (7) as a toggle for this function.

Pressing MENU (7) → F3 the first time will cause the frequency numbers shown at the bottom of the display window to be replaced by asterisks (****).

When it is desired to return to the normal frequency display mode, MENU (7) → F3 is again pressed and the numbers indicating the frequency will return.

Non-Volatile Memory

The PPM system's Non-Volatile Memory is intended primarily to provide a means to Store front panel settings for later Recall. This is particularly useful when complicated setups are in use. Usage of this feature can save many menu selections that might otherwise have to be entered every time the instrument is used.

The PPM stores all front panel information pertaining to the present setup in a memory location called "Current Setup". When the PPM is turned off, Stored setups and the Current setup in memory are kept alive by a Lithium battery. (Exceptions are detailed in Appendix D on page 3-46.) The battery will ensure that the contents of the memory will be preserved for about six months.

When the PPM has been turned on and Self-Test either completed or bypassed, the opportunity will be presented to select "Last Setup at Turn-Off". If it is desired to use the PPM in the same manner as when it was last used, this feature of the Non-Volatile Memory is very convenient. Other features of the Non-Volatile Memory will be discussed next.

Memory Features

To access the Memory features of the PPM, press the MEM key. There are three levels of menus accessible by sequentially pressing the MEM key. In Appendix B, on page 3-39, the Memory Menus are shown in detail. If the Memory Menu is accessed accidently, return to the Data Display Mode is accomplished by pressing CLEAR.

Store Setup

The PPM has 10 Non-Volatile Memories for storing front panel setups. These are numbered from 1 through 10. To store the present PPM front panel setup in one of these 10 memories, press:

MEM (1) → F2 → nn → UNITS

Where nn is the number of the memory where the setup is to be stored (between 1 and 10). If no number were entered, the operation would be aborted when any Units key was pressed and the PPM would return to data display.

Recall Setup

To Recall a previously stored setup, press:

MEM (1) → F1 → nn → UNITS

Where "nn" is the number of the memory to be recalled (from 1 to 10). If no number is pressed, the operation is aborted when any Units key is pressed and the PPM will return to data display.

Get Power-On Setup

To retrieve from memory the front panel setup that was operative the last time the instrument was used before power-off or the rear panel RESET button was used, press:

MEM (1) → F3

CAUTION: This selection will erase the Current selection. If there should be any doubt as to whether the Current selection will be needed later, it is advisable to Store the setup in a numbered memory before executing the command.

Display Setups

When one of the Display Setup features of the PPM is activated, the panel settings of the selected setup are shown on the EL display screen. This is useful if it is desired to determine the exact parameters that were used for a particular setup, and allows checking whether or not the various settings are correct before making any measurements.

A. To Display the contents of the Current setup, press:

MEM (2) → F1

The PPM will then display the current instrument status readout in a screen by screen display mode. To scroll to the next screen display, press the F1 key for "More". To exit and return to the Data Display Mode, press F3.

B. To Display the contents of the Power-On setup, press:

MEM (2) → F2

The PPM will then display the Power-On instrument status readout screen by screen. To scroll to the next screen display, press the F1 key for "More". To exit and return to data display, press F3.

C. To Display a numbered memory setup, press:

MEM (2) → F3 → nn → UNITS

Where nn is the number of the memory (between 1 and 10) that is to be displayed. If no number is entered, the operation is aborted when any Units key is pressed and the PPM returns to data display.

The PPM will display the instrument status readout of the Memory screen by screen. To scroll to the next screen display, press the F1 key for "More". To exit and return to data display, press F3.

Initializing Setups

This feature of the PPM allows the initializing of the current setup, a numbered memory setup, or all but the current setup. "Initializing" resets the selected setup's parameters to the factory default settings. Certain parameters are not initialized. These are listed in Appendix D on page 3-45. The Initializing function can be useful if, for some reason, the operator gets lost or has difficulty interpreting readings due to the complexity of a particular setup. Initializing also allows parameter settings to be made from a "known" status.

A. To Initialize the Current setup, press:

MEM (3) → F1

CAUTION: This selection will erase the Current setup. If there is any doubt as to whether or not the Current setup will be used again, it is advisable to Store the setup in a numbered memory before executing the command.

B. To Initialize all memory setups except for the Current setup, press:

MEM (3) → F2

NOTE: It is a good idea to Display the contents of the numbered memory setups before executing this command to see if it is desired to retain any of the setups in question.

C. To Initialize a numbered Memory setup, press:

MEM (3) → F3 → nn → UNITS

Where nn is the number of the memory (between 1 and 10) to be initialized. If no number is entered, the operation is aborted when any Units key is pressed and the routine will return to data display.

Model 1018B Peak Power Meter Emulation

General

The Wavetek Model 1018, 1018A, and 1018B series of peak power meters were the predecessors to the Model 8501A/8502A meters. This 1018 series was first produced in 1969, and has had several design up-grades. In 1978 Pacific Measurements, Inc. (now known as Wavetek Microwave, Inc.) added limited IEEE Bus capability to the 1018, but no provision was available for controlling front panel states. Only the cursor delay, trigger or reset, and the taking of data was remotely controllable.

The purpose of the 1018B emulation mode is to provide a means for current users of the 1018B to quickly adapt to using the 8501A/8502A meters in automatic systems. While "perfect" emulation is not possible, the PPM can mimic certain operations of the 1018B. This emulation only relates to GPIB (IEEE Bus) operations. That is, the ability to reset, trigger, alter the cursor delay, and take a power reading over the bus. For detailed information on GPIB operations with the PPM, see the IEEE Bus Interface chapter of this manual.

Although software written for the 1018B series would not take advantage of many of the new features of the PPM, the emulation capability can allow work to continue while new software is being written for the PPM.

NOTE: In order to use the 1018B software with the PPM in the 1018B Emulation Mode, the software must be written so that the talk and listen addresses of the PPM are both the same. For further information, see the 1018B Emulation discussion on page 4-26 of the IEEE Bus chapter of this manual.

Initiating the 1018B Emulation Mode

To initiate the 1018B Emulation Mode, press:

MENU (8) → F2

Thereafter, MENU (8) is used to select settings relating to the way in which the PPM will emulate the 1018B. See the MENU (8) listing in Appendix B on page 3-41 for a listing of available settings. In order to know which selections to make, three questions must be answered regarding how the 1018B is presently being used on the IEEE Bus. These are:

1. Is SRQ Enabled or Disabled?
2. Is the instrument set up to output data upon being talk-addressed (automatic trigger reset), or does the instrument require a trigger reset (a GET or "?" command) to take a data point?

It should be noted that 1018B emulation is incompatible with the Ratio Mode, and once the routine is in the 1018B Emulation Mode the Fast Analog Output function cannot be accomplished. For further information, see page 4-26 in the IEEE Bus chapter..

3. What is the Talk/Listen address? (They must be the same.)

Based on these questions, use MENU (8) to select the appropriate settings. Use MENU (6) → F3 to set the PPM addresses.

Once the above has been done, it should be possible to swap a Model 1018B with option 05 (GPIB) with a Model 8501A or 8502A meter and continue operations.

To terminate the 1018B Emulation Mode, press:

MENU (10) → F2

APPENDIX A

SUMMARY OF COMMANDS

General

This Appendix contains a summary of the commands required to activate all of the various functions of the PPM. The commands are listed for each of the different modes of operation (All, CW, Peak, Graph, Dual Channel, and 1018B Emulate) of the instrument.

Following page 3-46, Appendix D, is a reproduction of the laminated Quick Reference Card that will be included with all finished manuals. This card shows all of the functional commands in each testing mode, as well as how to get from one mode to another. The reverse side of the card gives a Quick Reference to all of the major menus shown in Appendix B.

NOTE: The UNITS indication at the end of (or included with) some of the command keystroke sequences means to press any of the three Units keys (ms, µs, or ns) to enter the keyboard value in the desired units.

Commands Applicable to All Modes

Auto Zero Detectors	MENU (1) → F3 → F2
Calibrate Detectors	MENU (1) → F3 → F1
Self-Test the Instrument	MENU (11) → F2
Service Functions	MENU (11) → F1
Detector Offset (Channel A)	MENU (3) → F1 → sn.nn → dB
Detector Offset (Channel B - 8502A only)	MENU (3) → F2 → sn.nn → dB
Frequency Correction	FREQ (follow prompts)
Change Frequency Correction to User Freq/PROM	MENU (3) → F3 → F1 → nnn.nnn → GHz
Change Frequency Correction to V/GHz/PROM	MENU (3) → F3 → F2 → vv.vv → UNITS → ss.ss → UNITS → ff.ff → GHz
Change Frequency Correction to Cal Factor (dB)	MENU (3) → F3 → F3 → A or B → sn.nn → dB
Change Between dBm and mW Display Units	MENU (4) → F3 (toggle)
Hide/Display Frequency Information	MENU (7) → F3 (toggling is done by pressing MENU seven times after either hiding or displaying frequency)
Review Detector PROM Information	MENU (10) → F2 (for A) or F3 (for B)
Check Date and Time then Exit	MENU (5) → F3 → F3
Change Date and Time then Exit	MENU (5) → F3 → F1 → mmddyy → UNITS → hhmmss → UNITS → F3

Set Max and Min Power Limits	MENU (7) → F1 → nn.nn → UNITS → nn.nn → dBm
Frequency or Cal Factor or V/GHz	FREQ (follow prompts)
Recall Setup in Memory (n)	MEM (1) → F1 → n → UNITS
Store Setup in Memory (n)	MEM (1) → F2 → n → UNITS
Recall Power-On Setup	MEM (1) → F3
Display Current Setup	MEM (2) → F1 → F1 or F3 (F3 = Exit; F1 = More)
Display Power-On Setup	MEM (2) → F2 → F1 or F3 (F3 = Exit; F1 = More)
Display Setup in Memory (nn)	MEM (2) → F3 → nn → UNITS → F1 or F3 (F3 = Exit; F1 = More)
Re-Initialize Current Setup	MEM (3) → F1
Re-Initialize All But Current Setup	MEM (3) → F2
Re-Initialize A Numbered (nn) Setup	MEM (3) → F3 → nn → UNITS

CW Mode Commands

Select CW Mode	CW
CW Averaging	MENU (2) → F1 → nnn → UNITS
Fast Analog Output	MENU (10) → F1

Peak Mode Commands

Select Peak Mode	PEAK
Select 8501A Internal Trigger and Level	MENU (1) → F1 → nn.nn → dBm mW
Select 8502A Internal Trigger and Level	MENU (1) → F1 → A or B → nn.nn → dBm mW
Select External Trigger	MENU (1) → F2
Fast Analog Output	MENU (10) → F1
Peak Averaging	MENU (2) → F2 → nnn → UNITS
Enable Cursor Delay	↑ or ↓
Disable Cursor Delay	UNITS
Enter Reference Delay	MENU (4) Ä F1 (for CH A or F2 for CH B of the 8502A) Ä nn.nn Ä UNITS

Clear Reference Delay	MENU (4) → F1 (for CH A and/or F2 for CH B of the 8502A) → 0 → UNITS

Graph Mode Commands

Select Graph Mode (from single channel operation only)	GRAPH
Autoscale	AUTOSCALE
Select 8501A Internal Trigger and Level	MENU (1) → F1 → nn.nn → dBm mW
Select 8502A Internal Trigger and Level	MENU (1) → F1 → A or B → nn.nn → dBm mW
Select External Trigger	MENU (1) → F2
Peak Averaging	MENU (2) → F2 → nnn → UNITS
Enter Reference Delay	MENU (4) → F1 (for CH A or F2 for CH B of the 8502A) → nn.nn → UNITS
Clear Reference Delay	MENU (4) → F1 (for CH A and/or F2 for CH B of the 8502A) → 0 → UNITS
GPIB Plot (Paper)	MENU (2) → F3 → F1
GPIB Plot (Transparency)	MENU (2) → F3 → F2
Code Number Entry for Plot	MENU (5) → F1 → nnnn → UNITS (nnnn = up to 12 digits)
Part Number Entry for Plot	MENU (5) → F2 → nnnn → UNITS (nnnn = up to 12 digits)
Abort (Stop) Plotting Activity	MENU (6) → F1
Enter Plotter GPIB Address	MENU (6) → F2 → nn → UNITS
Set Initial Delay for Autoscaling (Normal PPM operation)	MENU (11) → F2 → nn.nn → UNITS
Set Averaging Value for Autoscaling (Normal PPM operation)	MENU (11) → F3 → nnn → UNITS
* Set Initial Delay for Autoscaling (1018B emulation operation)	MENU (11) → F2 → nn.nn → UNITS
* Set Averaging Value for Autoscaling (1018B emulation operation)	MENU (11) → F3 → nnn → UNITS

* only valid after 1018B Emulation has been entered

Change Between Cursor, Marker, and Pulse Sub-Modes

PULSE/CURSOR/MARKER (triple toggle)

Cursor Sub-Mode Commands

Change Start Delay	Move Δ icon to STRT DLY line on display, enter change using nn.nn → UNITS or spin knob
Change Window Delay	Move Δ icon to DLY WIND line on display, enter change using nn.nn → UNITS or spin knob
Change Cursor Delay	Move Δ icon to CSR DLY line on display, enter change using nn.nn → UNITS or spin knob
Change Internal Trigger Level	Move Δ icon to TRG LEV line on display, enter change using nn.nn → UNITS (or spin knob), or use MENU (1) → F1 → nn.nn → UNITS
Change Reference Power (100% Point)	Move Δ icon to REF PWR line on display, enter change using nn.nn → UNITS

Pulse Sub-Mode Commands

Change Pulse Width Start and End Percentages	Move Δ icon to PULSE WID line, nn.n → UNITS → nn.n → UNITS
Change Rise Time Start and End Percentages	Move Δ icon to RISE TIME line on display, nn.n → UNITS → nn.n → UNITS
Change Fall Time Start and End Percentages	Move Δ icon to FALL TIME line on display, nn.n → UNITS → nn.n → UNITS

Marker Sub-Mode Commands

Change Marker 1 Percentage	Move Δ icon to MRKR 2-1 line on display, snn.n → UNITS
Change Marker 2 Percentage	Move Δ icon to MRKR 3-2 line on display, snn.n → UNITS
Change Marker 3 Percentage	Move Δ icon to MRKR 4-3 line on display, snn.n → UNITS
Change Marker 4 Percentage	Move Δ icon to 4th line on display, snn.n → UNITS

NOTE: Entering nn.n (positive) places the marker on the rising edge.
Entering -nn.n (negative) places the marker on the falling edge.

Dual Channel Operation

CW Mode Commands

From Initial Power-On select CW → B

If the Dual Channel state is being entered from some other state, use the channel A and B keys. When both A and B keys are lit, the Dual Channel state has been activated.

Peak Mode Commands

Assuming that there is an "Autoscalable" pulsed signal greater than the current trigger level at the channel A detector input, from initial Power-On select:

GRAPH → AUTOSCALE . . . PEAK → B

This method uses the Graph Mode to ensure that the cursor is placed on the pulse measured by channel A.

The GRAPH → AUTOSCALE keystrokes can be omitted, but this method does not guarantee that the cursor will be placed on the pulse. To find the pulse, use the procedures outlined in Peak, Peak Measurements, Method 1, on page 3-29.

Other Dual Channel Commands

Detector Offset (Channel B)	MENU (3) → F2 → nn.nn → dB
Display Ratio A/B Power Mode	MENU (7) → F2
Select Peak Mode for Channel A	A → F1 (when using the Ratio Mode)
Select CW Mode for Channel A	A → F2 (when using the Ratio Mode)
Select Peak Mode for Channel B	B → F1 (when using the Ratio Mode)
Select CW Mode for Channel B	B → F2 (when using the Ratio Mode)
Exit Ratio Mode	CW or PEAK

IEEE & 1018B Emulation Commands

Select PPM Listen and Talk Address	MENU (6) → F3 → nn → UNITS
Initiate 1018B Emulation Mode	MENU (8) → F2
* Disable/Enable Service Request	MENU (8) → F1 (Toggle)
* Automatic/Bus Command Trigger Reset	MENU (8) → F2
* Get Data Fast (No EL Display)	MENU (8) → F3
* Set Measurement Range	MENU (9) → F1 (for nnn.n µW) MENU (9) → F2 (for nn.nn mW) MENU (9) → F3 (for n.nnn mW)
* End 1018B Emulation Mode	MENU (10) → F2

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* These commands only valid after initiating 1018B Emulation Mode.

APPENDIX B

MENU DISPLAYS

MENU Key Displays

The following displays are activated by repeatedly pressing the MENU key. MENU (1) means the key is pressed once. MENU (2) indicates the key is pressed twice, etc.

Following page 3-46, Appendix D, is a reproduction of the laminated Quick Reference Card that will be included with all finished manuals. This card shows the functional commands on one side, and all of the major menus given in this Appendix B on the other side.

Two types of Menu displays are presented. These include Menus for normal 8500A functions, and the Menus that are used during 1018B Emulation. MENU (8) in the normal mode is used to enable the 1018B Emulation mode.

NORMAL 8500A FUNCTIONS

Keystrokes	Menu Displayed
MENU (1):	*Menu = NEXT MENU;*

F1 set Int Trig and Level	*F2 set Extrn Trigger*	*F3 to Cal or Zero Detectors*

MENU (2):	*Menu = NEXT MENU; Minus = PREV MENU*

F1 to Enter CW Averaging Number	*F2 to Enter Peak Averaging Number*	*F3 for GPIB Plot*

MENU (3):	*Menu = NEXT MENU; Minus = PREV MENU*

F1 to Enter Detector A Offset	*F2 to Enter Detector B Offset*	*F3 to Enter Source of Frequency Correction*

NOTE: F2 does not apply to the Model 8501A

MENU (4):	*Menu = NEXT MENU ; Minus = PREV MENU*

F1 to Enter Detector A Ref Delay	*F2 to Enter Detector B Ref Delay*	*F3 to Select mW Format*

NOTE: F2 does not apply to the Model 8501A

MENU (5): *Menu = NEXT MENU; Minus = PREV MENU*

F1 to Enter Code Number	*F2 to Enter Part Number*	*F3 for Read and Set Time*

MENU (6): *Menu = NEXT MENU; Minus = PREV MENU*

F1 to Abort Current Plotting Activity	*F2 to Enter Plotter Adress*	*F3 to Enter 8500A Listen and Talk Address*

MENU (7): *Menu = NEXT MENU; Minus = PREV MENU*

F1 to Set Max and Min Power Limits	*F2 to Select Ratio Display Mode*	*F3: Hide* (or Display) *Frequency Information*

NOTE: F2 does not apply to the Model 8501A

MENU (8): (When in normal 8500A mode)

Menu = NEXT MENU; Minus = PREV MENU

F2:
Emulate
1018B

MENU (9): (When in normal 8500A mode)

Menu = NEXT MENU; Minus = PREV MENU

F1 to Program Detector PROM	*F2 to Set Initial Dly Value for Autoscaling*	*F3 to Set Averaging Value for Autoscaling*

NOTE: The **MENU (9) → F1** key's function is designed to be used **only** in conjunction with the WMI PROM Programming Accessory Kit, P/N 16976. The instructions included with the Kit describe F1's usage.

If F1 were pressed without any requirement for using the PROM Programming device, a long series of submenus would normally have to be stepped through in order to escape from the routine. To circumvent this, press the RESET button on the rear of the instrument to go back to the last measurement mode.

MENU (10) (When in normal 8500A mode)

Menu = NEXT MENU; Minus = PREV MENU

F1 for	*F2: Review*	*F3: Review*
Fast Analog	*'A' Detector*	*'B' Detector*
Output	*PROM*	*PROM* (8502A only)

MENU (11): (When in normal 8500A mode)

Minus = PREV MENU

Be Sure No RF is Applied to Detector
Press CLEAR To Skip All Tests

F1 For	*F2 For*
Service Fncts	*Self Test*

1018B EMULATION MODE FUNCTIONS

MENU (8): (1018B Emulate Mode, Bus Trigger Reset, SRQ Enabled)

Menu = NEXT MENU; Minus = PREV MENU

F1 to	*F2 for*	*F3 to*
Disable SRQ	*Automatic*	*Get Data*
(Service	*Trigger*	*Fast; No EL*
Request)	*Reset*	*Data Display*

MENU (8): (1018B Emulate Mode, Auto Trigger Reset, SRQ Disabled)

Menu = NEXT MENU; Minus = PREV MENU

F1 to	*F2 for*	*F3 to*
Enable	*Bus Command*	*Get Data*
Service	*Trigger*	*Fast; No EL*
Request	*Reset*	*Data Display*

MENU (9): (When in 1018B Emulate Mode)

Menu = NEXT MENU; Minus = PREV MENU
Current Range Value is X

F1 for	*F2 for*	*F3 for*
Range 1	*Range 2*	*Range 3*
(XXX.X µW)	*(XX.XX mW)*	*(X.XXX mW)*

MENU (10): (When in 1018B Emulate mode)

Press CLEAR to return to data display
Menu = NEXT MENU; Minus = PREV MENU

	F2 to End 1018B Emulation	

MENU (11): (1018B Emulate mode only. Same as MENU (9) for the normal 8500A mode.)

MENU (12:) (1018B Emulate mode only. Same as MENU (10) for the normal 8500A mode.)

MENU (13): (1018B Emulate mode only. Same as MENU (11) for the normal 8500A mode.)

MEM Key Displays

The following menus are activated by repeatedly pressing the MEM key. MEM (1) indicates to press the key once. MEM (3) indicates to press the MEM key three times.

MEM (1): *Press MEM for additional selections*

F1 to Recall Setups	*F2 to Store Setups*	*F3 to get Power-On Setup*

MEM (2): *Press MEM for additional selections*

F1 to Display Current Setup	*F2 to Display Power-On Setup*	*F3 to Display a Numbered Setup*

MEM (3): *Press CLEAR to return to data display*

F1 to Re-Initialize the Current Setup	*F2 to Re-Initialize All but Current Setup*	*F3 to Re-Initialize a Numbered Setup*

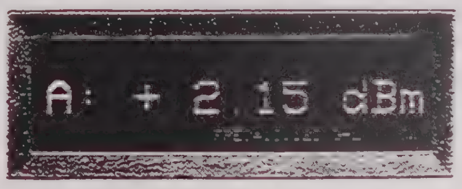
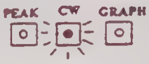
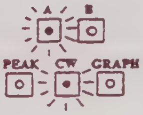
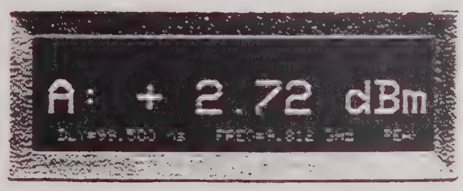
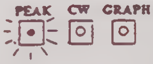
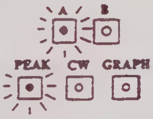
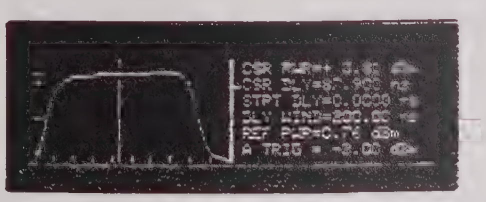
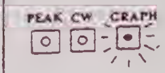
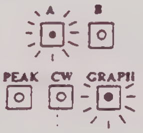
APPENDIX C

DATA DISPLAY FORMATS

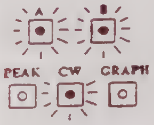
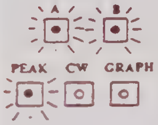
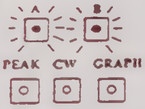
General

This Appendix shows photos of the major display formats that will be presented in each of the operating modes of the PPM. To the right of the photos are depicted the front panel keys that will be lighted to indicate what functions are in use to produce the particular display. The keys are shown for both the Model 8501A and Model 8502A since the 8502A is equipped with "A" and "B" channel keys that are not on the 8501A, and keys lit during the dual channel operation of the 8502A would not be applicable for the Model 8501A.

Data Displays

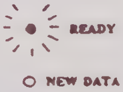
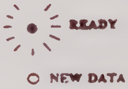
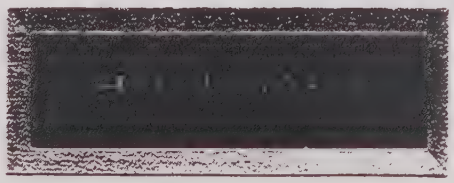
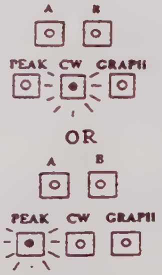
MODE	DATA DISPLAYS	8501A	8502A
Channel A CW Mode		 PEAK CW GRAPH	 A B PEAK CW GRAPH
Channel A PEAK Mode		 PEAK CW GRAPH	 A B PEAK CW GRAPH
Channel A GRAPH Mode (Cursor Sub-Mode)		 PEAK CW GRAPH	 A B PEAK CW GRAPH

Channel B displays are same as above, only with the "B" key lit and "B:" shown on the LCD display.

MODE	DATA DISPLAYS	8501A	8502A
Dual Channel CW Mode		N/A	 A B PEAK CW GRAPH
Dual Channel PEAK Mode		N/A	 A B PEAK CW GRAPH
Dual Channel RATIO Mode (A = PK Signal) (B = PK Signal)		N/A	 A B PEAK CW GRAPH

For ratioing various types of signals to each other, the indication in the lower right corner would be:

A = Peak; B = CW = "PK/CW"
Both A & B = CW = "CW/CW"
A = CW; B = Peak = "CW/PK"

Any Mode	Error Indicated Display Blank or Frozen No Trigger Occuring	 READY NEW DATA	 READY NEW DATA
Select A or B Channel		N/A	 A B PEAK CW GRAPH OR A B PEAK CW GRAPH

APPENDIX D

PPM DEFAULT SETTINGS

Factory-programmed settings of various user defineable functions have the following defaults whenever there have been no changes made in the settings by the operator during any testing routines.

FUNCTION	DEFAULT SETTING
Averaging	CW: 4 samples; Peak: 4 samples
Internal Trigger Level (A & B)	-10 dBm
Frequency	1.00 GHz
Offset	0 dB
Cursor Delay (A & B)	1.0000 microseconds
Start Delay	0.0000 nanoseconds
Delay WIndow (A & B)	10.0000 microseconds
Reference Power Level (A & B)	0 dBm
Reference Delay (A & B)	0.0000 microseconds
Cal Factor	0 dB
Mode	Channel A, CW power, dBm
Trigger Mode	Channel A, Internal
Pulse Width Start	50%
Pulse Width End	50%
Rise Time Start	10%
Rise Time End	90%
Fall Time Start	90%
Fall Time End	10%
Marker 1	2.5% (A and B)
Marker 2	17.8% (A and B)
Marker 3	46.9% (A and B)
Marker 4	90% (A and B)

(continued on next page)

The following settings are not affected by power-on, initialization, and setup store or recall:

Maximum Power	+20.5 dBm
Minimum Power	-45.0 dBm
Autoscale Average Number	4
Autoscale Initial Delay	75 µs
Plotter Address	6
PPM Address	4
Source of Frequency Correction	a) User supplied (as input, default = 1 GHz) b) V prop F, parameters not subject to store/recall or initialization c) Cal Factor, not subject to store/recall or initialization
Frequency Display	Displayed

MODEL 8501A/8502A FUNCTIONAL COMMANDS - QUICK REFERENCE CARD

Shown below is a listing of all of the commands required to manually activate the various functions of the instruments. The listing gives the specific commands pertaining to each discrete mode of operation (All Modes, CW, Peak, Graph, Dual Channel, and 1018B Emulation), and is formatted to show how to get from one mode to the other (e.g. large arrows between the mode selections indicate the name of the key to press to go from one mode to the other in the direction the arrow is pointing). For a more complete discussion of the commands, see Appendix A on page 3-34 of the Operation chapter (Chapter 3) in the Model 8501A/8502A Operating and Maintenance Manual.

Commands Applicable to All Modes

Auto Zero Detectors	MENU (1) → F3 → F2
Calibrate Detectors	MENU (1) → F3 → F1
Self-Test the Instrument (If desired during a test routine)	MENU (11) → F2
Service Functions	MENU (11) → F1
Detector Offset (Channel A)	MENU (3) → F1 → sn.nn → dB
Detector Offset (Channel B - 8502A only)	MENU (3) → F2 → sn.nn → dB
Frequency Correction	FREQ (follow prompts)
Frequency Correction - User Freq/PROM	MENU (3) → F3 → F1 → nnn.nnn → GHz
Frequency Correction - V/GHz/PROM	MENU (3) → F3 → F2 → vv.vv → UNITS → ss.ss → UNITS → ff.ff → GHz
Frequency Correction - Cal Factor (dB)	MENU (3) → F3 → F3 → A or B → sn.nn → dB
Change Between dBm and mW Units	MENU (4) → F3 (toggle)
Hide/Display Frequency Information	MENU (7) → F3 (toggle)
Review Detector PROM Information	MENU (10) → F2 (for A) or F3 (for B)
Check Date and Time then Exit	MENU (5) → F3 → F3
Change Date and Time then Exit	MENU (5) → F3 → F1 → mmddyy → UNITS → hhmmss → UNITS → F3
Set Max and Min Power Limits	MENU (7) → F1 → nn.nn → UNITS → nn.nn → UNITS
Recall Setup in Memory (n)	MEM (1) → F1 → n → UNITS
Store Setup in Memory (n)	MEM (1) → F2 → n → UNITS
Recall Power-On Setup	MEM (1) → F3
Display Current Setup	MEM (2) → F1 → F1 or F3 (F3 = Exit; F1 = More)
Display Power-On Setup	MEM (2) → F2 → F1 or F3 (F3 = Exit; F1 = More)
Display Setup in Memory (nn)	MEM (2) → F3 → nn → UNITS → F1 or F3 (F3 = Exit; F1 = More)
Re-Initialize Current Setup	MEM (3) → F1
Re-Initialize All But Current Setup	MEM (3) → F2
Re-Initialize A Numbered (nn) Setup	MEM (3) → F3 → nn → UNITS

CW Mode Commands

CW Averaging	MENU (2) → F1 → nnn → UNITS
Fast Analog Output	MENU (10) → F1

PEAK

CW

GRAPH

CW

PEAK

Peak Mode Commands

Select 8501A Internal Trigger & Level	MENU (1) → F1 → nn.nn → dBm mW
Select 8502A Internal Trigger & Level	MENU (1) → F1 → A or B → nn.nn → dBm mW
Select External Trigger	MENU (1) → F2
Fast Analog Output	MENU (10) → F1
Peak Averaging	MENU (2) → F2 → nnn → UNITS
Enable Cursor Delay	↑ or ↓
Disable Cursor Delay	UNITS
Enter Reference Delay	MENU (4) → F1 for CH A (or F2 for CH B of the 8502A) → nn.nn → UNITS
Clear Reference Delay	MENU (4) → F1 for CH A (or F2 for CH B of the 8502A) → 0 → UNITS

GRAPH

Graph Mode Commands

Select 8501A Internal Trigger & Level	MENU (1) → F1 → nn.nn → dBm mW
Select 8502A Internal Trigger & Level	MENU (1) → F1 → A or B → nn.nn → dBm mW
Select External Trigger	MENU (1) → F2
Peak Averaging	MENU (2) → F2 → nnn → UNITS
Set Initial Delay for Autoscaling (Normal PPM operation)	MENU (9) → F2 → nn.nn → UNITS
Set Averaging Value for Autoscaling (Normal PPM operation)	MENU (9) → F3 → nnn → UNITS
Enter Reference Delay (μs)	MENU (4) → F1 for CH A (or F2 for CH B of the 8502A) → nn.nn → UNITS
Clear Reference Delay	MENU (4) → F1 for CH A (or F2 for CH B of the 8502A) → 0 → UNITS

Change Between Cursor, Marker, and Pulse Sub-Modes	PULSE/CURSOR/MARKER (triple toggle)

Cursor Sub.Mode Commands

Change Start Delay (μs)	Move Δ icon to STRT DLY line on display, enter change using: nn.nn → UNITS or spin knob
Change Window Delay (μs)	Move Δ icon to DLY WIND line on display, enter change using: nn.nn → UNITS or spin knob
Change Cursor Delay (μs)	Move Δ icon to CRS DLY line on display, enter change using: nn.nn → UNITS or spin knob
Change Internal Trigger Level	Move Δ icon to TRG LEV on line on display, enter change using nn.nn → UNITS or spin knob, or use MENU (1) → F1 → nn.nn → UNITS
Change Reference Power (100% Point)	Move Δ icon to PWR REF line on display, enter change using: nn.nn → UNITS

Pulse Sub-Mode Commands

Change Pulse Width Start/End %	Move Δ to PULSE WID line on display, press nn.n → UNITS → nn.n → UNITS
Change Rise Time Start/End %	Move Δ to RISE TIME line on display, press nn.n → UNITS → nn.n → UNITS
Change Fall Time Start/End %	Move Δ to FALL TIME line on display, press nn.n → UNITS → nn.n → UNITS

Marker Sub-Mode Commands

Change Marker 1 Percentage	Move Δ to MRKR 2-1 line on display, press snn.n → UNITS
Change Marker 2 Percentage	Move Δ to MRKR 3-2 line on display, press snn.n → UNITS
Change Marker 3 Percentage	Move Δ to MRKR 4-3 line on display, press snn.n → UNITS
Change Marker 4 Percentage	Move Δ to 4th line on the display, press snn.n → UNITS

NOTE: Entering nn.n (positive) places the marker on the rising edge of the pulse.
Entering -nn.n (negative) places the marker on the falling edge of the pulse.

Other Dual Channel Commands

Detector Offset (Channel B)	MENU (3) → F2 → nn.nn → UNITS
Display Ratio A/B Power Mode	MENU (7) → F2
Select Peak Mode for Channel A	A → F1 (when using the Ratio Mode)
Select CW Mode for Channel A	A → F2 (when using the Ratio Mode)
Select Peak Mode for Channel B	B → F1 (when using the Ratio Mode)
Select CW Mode for Channel B	B → F2 (when using the Ratio Mode)
Exit Ratio Mode	CW or PEAK

IEEE & 1018B Emulation Commands

Select PPM Listen and Talk Address	MENU (6) → F3 → nn → UNITS
Initiate 1018B Emulation Mode	MENU (8) → F2
• Disable/Enable Service Request	MENU (8) → F1 (Toggle)
• Automatic/Bus Command Trigger Reset	MENU (8) → F2
• Get Data Fast (No EL Display)	MENU (8) → F3
• Set Measurement Range	MENU (9) → F1 (for nnn.n μW) MENU (9) → F2 (for nn.nn mW) MENU (9) → F3 (for n.nnn mW)
• Set Initial Delay for Autoscaling (1018B emulation operation)	MENU (11) → F2 → nn.nn → UNITS
• Set Averaging Value for Autoscaling (1018B emulation operation)	MENU (11) → F3 → nnn → UNITS
• End 1018B Emulation Mode	MENU (10) → F2

GPIB Plotting

GPIB Plot (Paper)	MENU (2) → F3 → F1
GPIB Plot (Transparency)	MENU (2) → F3 → F2
Code Number Entry for Plot	MENU (5) → F1 → nnnn → UNITS (nnnn = up to 12 digits)
Part Number Entry for Plot	MENU (5) → F2 → nnnn → UNITS (nnnn = up to 12 digits)
Abort (Stop) Plotting Activity	MENU (6) → F1
Enter Plotter GPIB Address	MENU (6) → F2 → nn → UNITS

* These commands only valid after entering 1018B Emulation Mode

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(Turn over for Menus)

MODEL 8501A/8502A MENU DISPLAYS - QUICK REFERENCE CARD

This side of this Quick Reference card shows a listing of the menus that will be displayed when the MENU or MEM keys are pressed. The numbers in parenthesis after the key designation indicate the number of times the key must be pressed to access that menu [i.e. MENU (3) means press the MENU key three times]. For a more complete discussion of the menus, see Appendix B on page 3-39 in the Operation chapter of the manual.

MENU Key Displays:

NORMAL 8500A FUNCTIONS

Keystrokes	Menu Displayed		
MENU (1):	*Menu = NEXT MENU*		
	F1 set Int Trig and Level	*F2 set Extrn Trigger*	*F3 to Cal or Zero Detectors*
MENU (2):	*Menu = NEXT MENU; Minus = PREV MENU*		
	F1 to Enter CW Averaging Number	*F2 to Enter Peak Averaging Number*	*F3 for GPIB Plot*
MENU (3):	*Menu = NEXT MENU; Minus = PREV MENU*		
	F1 to Enter Detector A Offset	*F2 to Enter Detector B Offset*	*F3 to Enter Source of Frequency Correction*
	NOTE: F2 does not apply to the Model 8501A		
MENU (4):	*Menu = NEXT MENU; Minus = PREV MENU*		
	F1 to Enter Detector A Ref Delay	*F2 to Enter Detector B Ref Delay*	*F3 to Select mW Format*
	NOTE: F2 does not apply to the Model 8501A		
MENU (5):	*Menu = NEXT MENU; Minus = PREV MENU*		
	F1 to Enter Code Number	*F2 to Enter Part Number*	*F3 for Read and Set Time*
MENU (6)	*Menu = NEXT MENU; Minus = PREV MENU*		
	F1 to Abort Current Plotting activity	*F2 to Enter Plotter Address*	*F3 to Enter 8500A Listen and Talk Address*
MENU (7):	*Menu = NEXT MENU; Minus = PREV MENU*		
	F1 to Set Max and Min Power Limits	*F2 to Select Ratio Display Mode*	*F3: Hide* (or Display) *Frequency Information*
	NOTE: F2 does not apply to the Model 8501A		
MENU (8):	(When in the normal 8500A mode) *Menu = NEXT MENU; Minus = PREV MENU*		
		F2: Emulate 1018B	
MENU (9):	(When in normal 8500 mode) *Menu = NEXT MENU; Minus = PREV MENU*		
	F1 to Program Detector PROM	*F2 to Set Initial Dly Value for Autoscaling*	*F3 to Set Averaging Value for Autoscaling*
	NOTE: F1 used only with PROM Programmer		
MENU (10)	(When in normal 8500A mode) *Menu = NEXT MENU; Minus = PREV MENU*		
	F1 for Fast Analog Output	*F2: Review 'A' Detector PROM*	*F3: Review 'B' Detector PROM* (8502A only)
MENU (11):	(When in normal 8500A mode) *Minus = PREV MENU* *Be sure no RF is applied to detectors* *Press CLEAR to Skip All Tests*		
	Press F1 For Service Fncts	*Press F2 For Self Test*	

MENU Key Displays: (con't.)

1018B EMULATION MODE FUNCTIONS

Keystrokes	Menu Displayed		
MENU (8):	(1018B Emulate Mode, Bus Trigger Reset, SRQ Enabled) *Menu = NEXT MENU; Minus = PREV MENU*		
	F1 to Disable SRQ (Service Request)	*F2 for Automatic Trigger Reset*	*F3 to Get Data Fast; No EL Data Display*
MENU (8):	(1018B Emulate Mode, Auto Trigger Reset, SRQ Disabled) *Menu = NEXT MENU; Minus = PREV MENU*		
	F1 to Enable Service Request	*F2 for Bus Command Trigger Reset*	*F3 to Get Data Fast; No EL Data Display*
MENU (9):	(When in 1018B Emulate Mode) *Menu = NEXT MENU; Minus = PREV MENU* *Current Range Value is X*		
	F1 for Range 1 (XXX.X µW)	*F2 for Range 2 (XX.XX mW)*	*F3 for Range 3 (X.XXX mW)*
MENU (10):	(When in 1018B Emulate mode) *Press CLEAR to return to data display* *Menu = NEXT MENU; Minus = PREV MENU*		
		F2 to End 1018B Emulation	
MENU (11):	(1018B Emulate mode only. Same as MENU (10) for the normal 8500A mode.)		
MENU (12:)	(1018B Emulate mode only. Same as MENU (11) for the normal 8500A mode.)		
MENU (13):	(1018B Emulate mode only. Same as MENU (12) for the normal 8500A mode.)		

MEM Key Displays:

Keystrokes	Menu Displayed		
MEM (1):	*Press MEM for additional selections*		
	F1 to Recall Setups	*F2 to Store Setups*	*F3 to get Power-On Setup*
MEM (2):	*Press MEM for additional selections*		
	F1 to Display Current Setup	*F2 to Display Power-On Setup*	*F3 to Display a Numbered Setup*
MEM (3):	*Press CLEAR to return to data display*		
	F1 to Re-Initialize the Current Setup	*F2 to Re-Initialize All but Current Setup*	*F3 to Re-Initialize a Numbered Setup*

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(Turn over for Commands)

CHAPTER 4

GPIB (IEEE BUS) INTERFACE

Introduction

This section of the manual is divided into several sub-sections to assist the user in obtaining required information as easily as possible. Once familiarization with the Model 8501A/8502A Peak Power Meter (PPM) commands and functions has been accomplished, controlling the instrument through the GPIB should be a fairly simple task. A first time user of the PPM should read the General Information section starting on this page before attempting to control the instrument over the bus, as this section provides all of the basic information required to begin programming.

The different sub-sections of these GPIB instructions will contain the following information:

General Information (Page 4-1)

General Information; Bus Functions; Menus; Modes of Operation; IEEE Output Modes; String Formats; Data Formats; Descriptive material on how the PPM functions over the GPIB; Simple Sample Programs

GPIB Command Descriptions (Page 4-9)

Command Descriptions by Function; Command Syntax; Sample Programs

Service Requests (Page 4-24)

Service Request (SRQ) Functions; Error Conditions

1018B Emulation (Page 4-26)

WMI Model 1018B Emulation; Limitations; Explicit and Implied 1018B Emulation

Status Code Decimal Values (Page 4-28)

Status Code Values - Normal; Command Errors; Operation Errors; Task Completion Codes, Normal and Abnormal; Critical Errors

Summary of Bus Functions (Page 4-29)

Summary of Bus Functions Implemented on the Model 8501A/8502A Power Meters

Command Summary (Page 4-29)

Command Summary Table
(Alphabetical Listing)

As previously mentioned, the user is advised to become conversant with the manual operation of the PPM before attempting to begin programming the instrument. Chapter 3 of this manual provides detailed information on controlling the instrument through the front panel.

The PPM allows several modes of GPIB operation. Power measurements can be taken in a variety of modes and formats. These range from simple CW measurements to complex graphic display capabilities of pulse profiles, complete with timing information.

The 1018B emulation feature allows the PPM to be installed in most test systems where the 1018B was previously used without the need for immediate reprogramming. The emulation can facilitate the usage of the PPM with the old 1018B software while work to write new code is under way.

General Information

This section will describe the various methods and modes that can be used for remotely controlling the PPM through the GPIB. Typical sample programs illustrating the use of commands will be given.

PPM IEEE Bus Functions

Remote operation of the PPM is accomplished through the GPIB under the control of a remote controller/calculator. Bus functions are implemented using the notation of the IEEE-488 1978 specification. These are given in the Bus Functions Summary section starting on page 4-29.

Bus Function Order of Events

The following is the general order of events when operating through the GPIB:

1. Parsing of Command String

2. Actions taken:

    a) Autoscale, if requested

    b) Power measurement, etc.

    c) Output of data upon TACS (Talker Active State)

It should be noted that it is necessary to wait for certain events to complete before sending new commands. Examples of such commands are AUTO and Marker Placement. If the PPM is placed in TACS and then untalked or if a new command string is sent, then the taking of data will be terminated as will the autoscale function if it is not yet complete. Failure of autoscale will result in a service request and the error condition of 60.

Completion will be signaled by the SRQ reporting either success or failure. If the command is AUTO and marker placement it is necessary to wait for AUTO success or failure, and then marker placement success or failure before expecting any time measurement output data from the PPM.

The controller should time out if the PPM does not complete the appropriate service requests in a reasonable amount of time; allowing for the autoscale average number, pulse repetition rate, etc.

It is recommended that commands be sent after Device Clear from the controller, to guarantee the state of the instrument. See Appendix D on page 3-45 of the Operations chapter for the default settings.

Any pulse profile related command (DUMG, Plot commands, and marker placement commands) will perform their operation on the collected data the moment they are received.

Throughout this IEEE Bus operation section of the manual, delays handled as arguments to commands sent to the PPM are listed as nnnnnn.nn µs. The PPM will accept resolution down to 0.1 ns or 0.0001 µs. A total of eight digits are allowed. The position of the decimal point can vary. Arguments should not be sent with excess digits to the right of the decimal point.

Front Panel Menus

(See Appendix B on page 3-39 of the Operation chapter for a complete listing of top level menus.)

Before attempting to remotely control the PPM over the bus, it should be kept in mind that there are various front panel menu selections that will affect bus activity. The front panel menu selections relating to the GPIB will include the following capabilities:

1. Enter the PPM address

    MENU (6) → F3 → nn → UNITS

2. Enter the plotter address

    MENU (6) → F2 → nn → UNITS

[UNITS means to press any of the Units keys (ms, µs, ns) to enter the keyboard value in the desired units.]

The address entries are self-explanatory; valid values are 0 to 30. The addresses entered are stored in nonvolatile memory and need not be re-entered when power is turned off and on again, only when they change.

3. Emulate 1018B (see page 4-26). The instrument will always power-on in the normal PPM mode, not the 1018B emulation mode.

4. Plot (see Plot Output Mode on page 4-5).

5. Stop current plotting activity (see Stand Alone Plot Output Mode on page 4-7 regarding the Stand Alone Plot function).

NOTE: Item 1 above, "Enter the PPM address" is most important as the PPM will not respond to bus commands unless this has been correctly accomplished.

Power-On Condition

When the PPM is first turned on, it will automatically go into its Self Test function. When Self Test has completed, the routine returns to the last setup before the instrument was powered off. After Self Test has completed, the instrument is also ready to receive instructions from the GPIB controller to go to the Remote state.

The address to place the PPM in Remote at power-on will be the same address that was used before power-off. (The default address is 4.)

Remote and Local Lockout Functions

The PPM is designed to only accept commands or output data through the bus when it is in the Remote state. It is placed in the Remote state by listen-addressing the instrument with REN asserted, per the IEEE-488 1978 standard. The PPM will ignore talk-addressing when it is not in the Remote state. Any GET (Group Execute Trigger) command or any data sent to the instrument when it is addressed while not in Remote will result in an error condion and a service request (if SRQ is enabled) will be generated.

When in Remote, the PPM's front panel keyboard will not be active except for an escape sequence to return to local control. The escape sequence is initiated by pressing the MENU key. At that time the PPM will suspend all operations, including IEEE Bus interaction. The measurement being displayed on the front panel will be replaced with a prompt to press the F1 key to return to local control, or to press the F2 key to abort the return to local escape sequence. The instrument will not respond to any other keystrokes. If F1 is pressed, the instrument will return to local control and resume normal manual operation. If F2 is pressed, the instrument will resume normal operations in the Remote state as though no action had occured. Once the unit has been returned to Local by using the front panel commands given above, it will return to remote the next time it is Listen-Addressed (LADS) with REN asserted.

Another method to return to Local is achieved by sending a GTL (Go To Local) command from the GPIB controller. The PPM will return to the Local control state when it receives this command, and can then be returned to the Remote state the next time it is listen-addressed with REN asserted.

Besides the return to local escape sequence and the GTL universal command, the PPM will also exit the Remote state when the REN line goes low.

Local Lockout

After the PPM has entered the Remote state, a Local Lockout command can be sent to it to disable the use of the front panel. This feature is intended to prevent accidental changes in front panel settings or interruption of the program.

When the instrument is in the Local Lockout mode, the Return to Local escape sequence activated by the MENU key is disabled. There is no way to regain control from the front panel once Local Lockout has been commanded.

To go to the Local Lockout mode, the Local Lockout (LLO) bus command must be sent to the PPM. The "LLO" light on the PPM's front panel will not be turned on at that time, but the instrument will be in the LLO state. At the next change in the state of the instrument, either a change in the addressed state of the PPM on the GPIB or any keystroke made on the front panel, the "LLO" light will turn on. If a front panel keystroke is made, it is ignored and will not affect the state of the instrument. Subsequent attempts to control the unit from the front panel will also be ignored.

Output Modes

The PPM is designed to output data over the GPIB in six different modes. In addition, the instrument has two speeds of data transmission: Data Normal and Data Fast. The default speed is Data Normal. The Data Fast mode allows high speed transfer of measurement data through the GPIB interface. While the Data Fast mode is in use, there will be no readings displayed on the PPM's front panel display. There are some functions that are not permitted in the Data Fast mode. These are detailed in the Data Fast Mode section on page 4-14.

The PPM can only be in one output mode when it is talk-addressed. For example, the unit cannot be programmed to plot and then immediately output the difference in temperature since the last calibration. If the PPM receives more than one output mode instruction, the most recent command will supercede all previous output commands.

The instrument must always be in an output mode. It sends output information when it receives a command to initiate another output mode, or when a current output mode is completed and terminates itself. The self terminating modes are Plot, Output Temperature Difference Since Calibration, Output Status Byte, and Stand Alone Plot. When these modes complete, the PPM will not send any more data until it is untalked (the Stand Alone Plot untalks itself). When untalked, the default output mode becomes either Update Data Trigger Reset or Update Data Continuously, depending on which mode was last initiated. When power is first applied to the instrument, the default output mode is Update Data Trigger Reset.

NOTE: Before selecting any of the PPM Output Modes described above, required parameters should be set so that the PPM data that is taken will be valid. For example, plotting commands will not work unless the PPM has been set to the Graph Mode.

Update Trigger Reset Output Mode

A. In order to access this mode of operation, a string of four characters must be sent over the bus to the PPM as follows:

"UPDT"

If BASIC is being used on an HP Series 200 computer, the command might look like:

```
OUTPUT 704;"UPDT"
```

where:

OUTPUT is the GPIB command to send the letters in quotation marks following the semicolon.

The 7 in the "704" is the HP instruction that the output is to go via the GPIB interface.

The 04 in the "704" is the Listen/Talk address of the PPM. The Listen/Talk address must be set by using the MENU key on the PPM's front panel. (See the Menu (7) description in Appendix B on page 3-40 of the Operation chapter of this manual.)

B. In the Update Trigger Reset Mode, the PPM will not take any data until it receives a trigger reset. When the trigger reset is received through the GPIB, the instrument is set to record the next measurement. If the instrument is in the Peak or Graph Mode, the measurement (power reading at the cursor location) will be taken the next time the instrument is triggered. Triggering can be either internal or external, depending on how the instrument has been configured by the user. The recorded measurement data will be output through the GPIB when the PPM next enters TACS (Talker Active State).

The trigger reset can take one of the following two forms:

1. The universal GPIB command, GET (Group Execute Trigger), can be sent over the bus when the PPM is listen-addressed.

or

2. The controller can send the PPM's "UPDN" (Update Data Now) command to act as a trigger reset (e.g. OUTPUT 704;"UPDN")

When the PPM completes the measurement and has the data ready to output, it will request service if it not in TACS and has SRQ enabled. Entering TACS will clear the service request if the instrument has not already been serviced directly by the GPIB controller program.

The procedure to trigger reset the PPM with the GET command consists of the following steps:

1. Listen-address the PPM.

2. Send the GET universal command.

3. Talk-address the PPM.

4. Release ATN to set the PPM in TACS.

5. If in the Peak Mode, send the pulse to trigger the PPM.

NOTE: As previously mentioned, if the pulse is sent before the PPM is in TACS, an SRQ will be generated if SRQ has been enabled. Entering TACS will clear the SRQ.

6. Read the power measurement string as it is sent by the PPM. The string will be terminated with a carriage return followed by a line feed character sent with EOI.

The procedure to trigger reset the PPM with the "UPDN" command is the same as using the universal GET command except that, after Step 1 when the PPM has been listen-addressed, the command string "UPDN" should be sent. The power measurement data output format is discussed on page 4-8.

<u>Sample Program:</u>

```
10    PRINT CHRS(12);
20    !  THIS PROGRAM USES THE
30    !  UPDATE TRIGGER RESET MODE
40    !  OF THE PPM TO COLLECT
50    !  POWER MEASUREMENT DATA.
60    !  "UPDN" RESETS THE PPM.  IT
65    !  IS THEN READY OR "ARMED".
70    !  THE PPM WILL SEND DATA
80    !  AFTER RECEIVING THE "UPDN"
90    !  COMMAND.
100   !
110   !  DATA ENTERED AS A STRING
```

```
120   !  D$ IS DISPLAYED, AND THEN
130   !  REPEATED CONTINUOUSLY.
140!
150   OUTPUT 704;"UPDT"
160   OUTPUT 704;"UPDN"
170   ENTER 704;D$
180   DISP D$
190   GO TO 160
200   END
```

NOTE: In the Dual Channel Mode, it is necessary to read the IEEE Bus twice to get A and B channel data.

Update Data Continuously Output Mode

A. In order to access this mode of operation, a string of four characters must be sent over the bus to the PPM as follows:

"UPDC"

If BASIC is being used with an HP Series 200 computer, the command might look like:

```
OUTPUT 704;"UPDC"
```

where:

OUTPUT is the GPIB command to send the letters in quotation marks following the semicolon.

The 7 in the "704" is the HP instruction that the output is to go via the GPIB interface.

The 04 in the "704" is the Listen/Talk address of the PPM. This address must be set from the front panel by using the MENU key. (See the MENU (7) description in Appendix B on page 3-40 of the Operation section of this manual.)

B. In the Update Data Continuously Mode, the PPM is ready to send a continuous stream of data points while it is in TACS (Talker Active State). Upon entering TACS, the PPM will initiate a trigger reset and be ready to record the next measurement. If the instrument is in the Peak or Graph Modes, the measurement (power reading at the cursor location) will be taken the next time the instrument is triggered. Triggering can be either internal or external, depending on how the user has configured the instrument.

Upon continuous triggering, measurement data points separated by commas will be sent by the PPM. Measurement data will continue to be sent through the GPIB separated by commas (every time a trigger occurs) until the instrument has been untalked.

Sample Program:

```
10    !  THIS PROGRAM USES "UPDC"
20    !  UPDATE DATA CONTINUOUSLY.
30    !  THE DATA IS SENT BY THE PPM
40    !  WHEN IT IS TALK ADDRESSED
50    !  WITH THE "ENTER" STATEMENT
60    !
70    OUTPUT 704;"UPDC"
80    !
90    !  TAKE 10 READINGS AND
100   !  DISPLAY THEM:
110   FOR I=1 TO 10
120   ENTER 704 USING "K,#";A$,A(I)
130   DISP A(I)
140   NEXT I
150   END
```

Plot Output Mode

In this mode the PPM sends HPGL plotter commands to plot a pulse on a compatible plotter. The PPM command "PLOT" initiates the capturing of a pulse and relevant information that will be plotted when the PPM enters TACS. The procedure to plot a graph over the GPIB consists of the following steps:

1. Prepare the PPM by entering the Graph Mode and obtaining the desired pulse profile to be plotted as shown in the PPM's display window. Also select which sub-mode you want because the data shown on the plot is different for each sub-mode. (For instance, selecting the Marker sub-mode will cause the marker values to be shown at the bottom of the plot.)

2. Send the PLOT command to the PPM.

3. Listen-address the plotter.

4. Talk-address the PPM.

5. Release ATN, putting the PPM in TACS.

The PPM will terminate the plot with a carriage return followed by a line feed sent with EOI. If necessary, the plot can be aborted by the untalking of the PPM during transmission of the plot.

Whenever the PLOT command is sent to the PPM while it is in the Graph Mode, the PPM will plot a graph of the selected sub-mode (Cursor, Pulse, or Marker). (See Figures 3-4, 3-5, and 3-6 on page 3-21 of the Operation chapter of this manual for typical plots of Graph sub-mode pulse profiles.)

Adding Serial & Code Numbers to a Plot

The following commands are used when it is desired to have any serial or code numbers appear on a hardcopy plot.

PLPNxxxxxx.......

(x = string of 12 or less characters
Plot part number, ASCII string)

PLCNxxxxxx......

(x = string of 12 or less characters
Plot code number, ASCII string)

Any printable character is allowed including spaces, except that all leading spaces prior to the first non-space character are stripped off, and not included in the number of characters in the string. The string must be terminated by a semicolon which is not printed. Therefore, no semicolons can be contained within a label string.

Sample Program:

```
10    !  THIS PROGRAM DEMONSTRATES
20    !  HOW TO MAKE THE PPM OUTPUT
30    !  A PULSE PROFILE DISPLAYED
40    !  IN THE GRAPH MODE TO A
50    !  DIGITAL PLOTTER.
60    !
70    !  "C$" AND "P$" ARE STRINGS
80    !  THAT CAN BE SENT SO THAT A
90    !  CODE NUMBER & PART NUMBER
100   !  ARE PRINTED ON THE PLOT BY
110   !  THE PPM.
120   !
130   C$="ABCDEFGHIJKL"
140   P$="123456789012"
150   !
160   !  AFTER ENTRY INTO THE GRAPH
170   !  MODE, THE FOLLOWING
180   !  COMMANDS WILL INITIATE THE
190   !  PPM'S PLOT ROUTINE.  THE
200   !  ADDRESS OF THE PLOTTER AND
210   !  PPM MUST BE SET CORRECTLY -
220   !  IN THIS CASE THE PPM IS AT 704,
230   !  AND THE PLOTTER IS AT 706.
240   OUTPUT 704;"PLCN"&C$
250   !  SEND CODE NUMBER TO PPM
260   OUTPUT 704;"PLPN"&P$
270   !  SEND PART NUMBER TO PPM
280   !
290   !  THESE ARE THE COMMANDS TO
300   !  INITIATE THE PLOT ROUTINE:
310   !
320   OUTPUT 704;"PLOT"
330   !  (PUTS PPM IN PLOT OUTPUT MODE)
340   !
350   SEND 7;UNL
360   SEND 7;LISTEN 6
370   !  (LISTEN ADDRESSES THE PLOTTER)
380   SEND 7;TALK 4
390   !  (TALK ADDRESSES THE PPM)
400   !
410   SEND 7;DATA
420   !  (RELEASES ATN LINE ALLOWING
430   !  PLOTTING TO BEGIN)
440   !
450   WAIT 180
460   !  WAIT UNTIL PLOTTING HAS
470   !  FINISHED BEFORE UNTALKING
480   !  THE PPM.  PLOT TAKES ABOUT
490   !  3 MINUTES
500   !
510   !  UNTALK AND UNLISTEN ALL BUS
520   !  DEVICES
530   SEND 7;UNT UNL
540   END
```

Temperature Difference Output Mode

This mode can be used to determine the difference in temperature for each detector since it was last calibrated. The mode provides a means to maintain measurement accuracy by allowing the software to determine when a detector Self-Cal is required. If detector temperature difference information is desired, the command DTMP is sent to the PPM. The instrument will then be ready to output a data string in the following format: (x and y = temperature reading digits; s = polarity)

DTPAsxx.x,DTPBsyy.y(CR)(LF-EOI)

This will be true with both the Model 8501A and 8502A instruments. If no detector is present, the digit portion of the string will read +00.0. The zeros can either mean no change in temperature difference or no detector present. With the 8501A, the "B" reading will always be zeros.

Sample Program:

```
10    !  THIS PROGRAM EXTRACTS
20    !  TEMPERATURE INFORMATION
30    !  FROM THE PPM SO THAT A
40    !  CONTROLLER CAN DETERMINE
50    !  IF A SELF-CAL IS REQUIRED.
60    !  IF THE TEMP SINCE LAST SELF-
70    !  CAL IS MORE THAN +/-5 DEG-C,
80    !  SELF-CAL IS RECOMMENDED
90    DIM A$(19)
100   !
110   !
120   OUTPUT 704;"DTMP"
130   ENTER 704;A$
140   DISP A$
150   END
```

Status Byte Output Mode

The PPM uses this mode to send its status byte out through the GPIB as a character string. The value sent is the internal status value, thus it is not exactly the same as the byte sent during a serial poll in which bit 7 is high when service is being requested (see Service Requests, on page 4-24). The character string sent out to represent the status value will consist of a four character head, STAT, followed by three digits. This output mode can only be active when SRQ is disabled. Service request status bytes are not buffered when SRQ is disabled, so only the most recent status value will be output. The status value is followed by a carriage return, followed by a line feed sent with EOI.

Stand Alone Plot Output Mode

Plotting Without Using a Controller

The PPM uses this mode to send HPGL digital plotter commands to plot a pulse, much as it does in the Plot Mode. The difference is that stand alone plots are initiated by commands from the front panel of the PPM. This is to allow plotting without the use of a controller. (See Digital Plotting of Graphic Data on page 3-20 of the Operation chapter.)

Stand Alone Plot Output Mode: PPM Internal Procedures

This section describes what actions are performed by the PPM when the Stand Alone Plot is initiated from the front panel. Before the PPM can output plotter information, it is first necessary to enter the Graph Mode of operation. The Operation Section of this manual contains the information required to prepare for and produce digital plots of Graph Mode and Marker sub-mode data. The following paragraphs will describe the PPM's internal procedures for GPIB interaction when front panel plots are to be made.

When the PPM has "drawn" a complete pulse profile on its display, it is ready to act as a GPIB controller. When the plot routine is activated, the PPM checks to make sure that there is no other active controller on the bus. If the PPM is in the Remote state, it implies that a controller is present and registers as a GPIB bus error. Also, all PPM service requests are generated by action on the GPIB, and are cleared when REN is dis-asserted (see Remote and Local Lockout on page 4-3). Therefore, if the PPM internally detects any abnormal status condition in its status byte, it will assume that there was recent activity on the bus involving a controller and refuse to proceed further with the plot. It will also attempt a service request to see if there is any response from the controller.

If the PPM does not detect an indication of another controller, it will assume that it is the only controller-capable device on the bus, and act as system controller. Depending on the system configuration, these checks made by the instrument may not be perfect.

CAUTION: For proper system operation, it is up to the user to be sure that no active controller is on the bus when the front panel function is initiated.

While the PPM is checking the state of the bus, it will display the message "Checking GPIB Interface", and the keyboard will be inactive.

If the PPM does detect an indication of a controller on the bus or if the PPM takes control of the bus and attempts to address the plotter but does not get a handshake, a GPIB bus error message will be displayed and a prompt will require F2 to be pressed to continue. If the PPM does not detect a bus error, a chime will sound and normal operation will resume while the plot is being sent over the GPIB. Once plotting has begun, control of the front panel will be returned to local.

NOTE: If it is desired to add serial and code numbers to the plot, use the information given in Step 5 of the Procedure for Making Plots on page 3-21 of the Operation chapter.

Command String Format

Control of the PPM is accomplished by using four character mneumonic commands. Some of these require one or more numerical entries (arguments). The command structure is intended to be taken literally; there are no "optional" formats. Thus, if two arguments are specified for a command, both must be given for the command to be processed.

A character string is terminated with a line feed character and/or an EOI. Carriage returns are ignored. Therefore, a carriage return/line feed sequence will act as a string terminator and will be treated as a line feed. More than one command (and respective arguments) can be sent in a command string as long as the string does not exceed 128 characters, including the terminator. (If an EOI is sent and the last character is not a line feed, only 127 characters can be sent.) None of the commands will be able to be processed until the string is terminated, and then they will be processed in the order in which they were given (see Output Modes on page 4-3 regarding conflicting output commands).

When the command string is received, it is first checked for syntax and numerical values and commands are reviewed to make sure they are valid. If a syntax error or an invalid data error is detected, or the execution of the command string would lead to an operation error, then none of the commands will be executed and a service request will be generated if SRQ is enabled.

A very forgiving syntax is allowed since the PPM can distinguish between any command and any argument, with no separator character required between commands or a command and its argument. The only time a separator character is required is between arguments when the command has two or more arguments. A separator is defined to be a space, a comma, or a semicolon. Any number of separators are allowed before the first command, between a command and an argument, between arguments, between the last argument of a command and the next command, or at the end of the string, without effecting the PPM's interpretation of the command string. Commands can be in upper or lower case format.
An argument consists of a digit string which can optionally be preceded by a " + " or " - " sign. If no sign is present, the number is assumed to be positive. The digit string can also contain a decimal point if desired. The dimension of each argument is fixed, therefore no dimensional identifier is needed or allowed, only a number. This will be described in the command description sections to follow. 1018B command arguments follow a different format as is discussed in 1018B Emulation on page 4-26.

Power Measurement Data Output Format

The measurement data output formats transmitted by the PPM over the GPIB depend on whether the PPM is in the "dBm" or "W" power mode of operation. These modes are entered by using GPIB commands as described in the Select Log or Linear Power section on page 4-14 or, when the PPM is not in the Remote mode, by pressing the dB/mW key on the front panel.

Power measurements over the GPIB are taken only during the Update Trigger Reset or Update Data Continuously output modes (See pages 4-4 and 4-5.)

To initiate the taking of a power measurement over the GPIB, a command is sent to the PPM from the controller and then talk-addressed. When the PPM has been triggered, it will transmit its data through the GPIB to the controller. See the command descriptions given in on the next page for the commands required to take data. The measurement data strings are discussed in subsequent sections.

Log (dbm) Data Format

When the PPM is in the dBm mode (as indicated in the EL readout window), the first three letters of the data string are DBM. This indicates that the data represents a dBm value. The following letter indicates which detector (channel A or B) was taking the measurement. This is followed by a polarity sign, and then a string of five digits with a decimal point after the third digit.

Each measurement taken in the Update Trigger Reset Mode will be terminated by a carriage return followed by a line feed sent with EOI. Measurements taken in the Update Trigger Continuously Mode will be separated with commas. Examples are:

Update Trigger Reset Mode:

```
DBMA-012.73(CR)(LF-EOI)
DBMB+002.47(CR)(LF-EOI)
```

Update Data Continuously Mode:

```
DBMA+016.74
DBMA+018.23
DBMA+017.34          (and so on)
```

The actual measurement string (less terminating and delimiting characters for each data point) will always be 11 characters long.

Linear Power (mW) Data Format

When the PPM is in the linear power mode (as indicated in the EL readout window), the first three characters of the data string will be PWR. This indicates that the measurement is a linear value, with the units always in WATTS. As with DBM, the next character indicates which detector (channel A or B) was taking the measurement. This is always followed by a value in engineering notation. The value consists of four digits and a decimal point. These are followed by an "E", then a polarity sign and two more digits. The digits following the E are always multiples of three. This makes it easier to determine if the data is being given in terms of microwatts, milliwatts, nanowatts, etc.

Each measurement taken in the Update Data Trigger Reset mode will be terminated by a carriage return followed by a line feed sent with EOI. Measurements taken in the Update Data Continuously mode will be separated by commas. Examples are:

Update Data Trigger Reset mode:

PWRA31.61E-06(CR)(LF-EOI)
for 31.61 microwatts

PWRB634.7E-03(CR)(LF-EOI)
for 634.7 milliwatts

Update Data Continuously mode:

PWRA64.98E-06,
PWRA65.23E-06,
PWRA89.32E-06,
and so on

The actual measurement string (less terminating or delimiting characters for each data point) will always be 13 characters long.

GPIB Command Descriptions And Functions

General Information

There are approximately 100 different commands available to program the PPM for use on the GPIB. This section will provide functional information pertaining to the commands with the least complex material covered first.

For most applications the automatic features of the PPM provide easy methods of making pulsed measurements. However, a great deal of flexibility and control is available if the user prefers to work with "raw" data.

An alphabetical listing of all commands will be found in the Command Summary section on page 4-30.

The PPM has the following general capabilities:

A. The ability to measure and output CW or Peak power, or a Ratio of two signals in Linear (Watts) or Log (dBm) format.

B. In some applications, the PPM can output the microwave frequency at which the power measurement is being taken.

C. Graphically display pulse profiles automatically.

D. Markers can be defined on the pulse.

E. Risetime, falltime, and pulse width can be measured and output automatically.

F. Time differences between selected markers can be measured and output automatically.

G. Self-test capabilities are built in.

H. The PPM Calibration function automatically linearizes the detector over a 50 dB power range for the most accurate power measurements.

I. The temperature of the detectors can be monitored to verify whether the detector should be recalibrated.

J. The PPM makes use of a PROM with stored frequency response data contained in the RF detector assembly. The instrument uses the stored data to automatically compensate for detector frequency response variations. A rear panel connector is available on the unit to connect a V/GHz signal to allow for automatic frequency selection and correction of measured power.

K. The use of balanced detectors enhances accuracy when used in situations where even harmonics are present.

L. Setups can be stored or recalled to and from the PPM's non-volatile memory by GPIB commands as well as manually through the front panel.

M. Graph displays can be plotted on digital plotters. In addition, data pertaining to a pulse profile can be output to the controller.

N. A "Data Fast" mode disables the front panel display, allowing faster bus operation.

O. Frequency information can be hidden when the PPM is used for classified testing.

NOTE: The Model 8501A instrument will respond to the same command sets as the Model 8502A. The only exception is that the 8501A only responds to commands relating to channel A.

Function Timing

Instrument functions that take a specific amount of time to complete will be noted with an asterisk (*) in the following discussion.

During the time the PPM is processing a function such as calibration, zeroing, or self test, the instrument will continue to be active on the bus. Any new commands may not be received if previous activity is not already completed. No output will be given and, if any commands are sent by the controller, only the first byte will be accepted. The PPM will then send "Not Ready for Data" until the function is complete.

When the particular function completes, the PPM will request service and send SRQ if SRQ has been enabled. Successful completion of the task is verified by checking the value of the status byte. A listing of Status Codes is given on page 4-28. If SRQ has not been enabled, the controller can only learn the result of the operation by asking for the status byte with the STAT command (see the next section).

Common Mode Functions

Calibration Commands

* CALA	Calibrate channel A detector
* CALB	Calibrate channel B detector

NOTE: It is advisable to use the PPM's SRQ capabilities to monitor whether the calibration has completed and is successful or not. A serial poll can be conducted, and the returned Status value interpreted. See the Service Request section on page 4-24 for SRQ features, and page 4-28 for applicable Status Code values.

Temperature Difference Since Last Calibration Commands

DTMP	Output the Difference in the temperature of each detector since calibration. This command causes the temperature to be read from each detector (or whatever detector is connected). It will be formatted as described on page 4-6, and is useful for determining whether recalibration of detectors should take place. Normally the PPM can maintain accuracy within ±5°C of the temperature of calibration.

Autozero Detectors Commands

* ZERA	Zero channel A detector
* ZERB	Zero channel B detector

Store Or Recall Setup Commands

STORnn

Store current PPM settings in non-volatile setup memory number n.

(n = number between 1 and 10)

RECLnn

Recall PPM setting from non-volatile memory n, and make it the current setting.

(n = number between 0 and 10. Setup number 0 cannot be used for storage - it is the last setup before power was turned off or the PPM received a Device Clear from the GPIB controller)

Hide And Unhide Front Panel Frequency Information Commands

FQHD	Hide the frequency information
FQDS	Display the frequency information

Output Status Byte Information Command

STAT Output status byte. This command will only be effective when SRQ is disabled. If it is received while SRQ is enabled, a service request will be generated.

Typical Program Lines:

```
OUTPUT 704;"STAT"
ENTER 704;A$
PRINT A$
```

SRQ Related Commands

SRQE	Enable SRQ
SRQD	Disable SRQ
UNDD	Disable SRQ only for underrange conditions. (Permits continuing data output without undesired SRQ interference.)
UNDE	Enable SRQ for underrange conditons.

Power Limits

The purpose of setting power limits is to alert the controller of two possibilities having occured. These are:

1. Overrange: Warns that the detector (or other component) may have been damaged, and data taken may be invalid.
2. Underrange: Warns that the power level being measured is low and may be inaccurate.

The PPM can be enabled to generate an SRQ for underrange conditions. The point at which the PPM sends an SRQ is determined by the MINP command. Data output during an underrange condition is as follows:

Log Mode:	-99.99dBm
Linear Mode:	0.000E-99

Overrange conditions always generate an SRQ (if SRQ is enabled), but normal data is still output. ***It should be kept in mind that if the detector is exposed to power levels in excess of +23 dBm, not only will the PPM's measurement accuracy be degraded, but damage or complete destruction of the detector's diode can occur.***

The commands for setting power limits are:

MAXPsnn.nn

Set power level (in dBm) for overrange condition.

(s = polarity; n = dBm; +21.00 max, -10.00 min)

MINPsnn.nn

Set power level (in dBm) for underrange condition.

(s = polarity; n = dBm; -15.00 max, -50.00 min)

Measurement Data Correction

Basic Data Correction Information

The manner in which the PPM is able to make very fast peak power measurements is dependent on the usage of zero bias schottky diode detectors as power sensing elements. These diodes have typical risetimes of less than 10 nanoseconds making them useful for pulsed RF applications. However, at microwave frequencies, it is necessary to compensate for the detector's non-linearity with frequency.

Each WMI detector used in the PPM has a built-in PROM which contains frequency correction data. Depending on the mode of operation, the PPM can be instructed to automatically subtract out the frequency non-linearity error from the power measurement being made.

In order for this automatic correction to take place, the PPM needs to know the frequency of operation. This can be done at the front panel, over the GPIB, or by the use of the Voltage Proportional to Frequency feature (V prop F). The V prop F is an analog voltage connected to the PPM's rear panel EXTERNAL FREQUENCY input connection. A voltage is usually available from most sweepers called V/GHz with a coefficient of 1V/GHz. This voltage can be converted to digital information by the PPM, and used as a "frequency input" instead of having to enter it by some other means.

In addition to automatic frequency correction, it may be desired in some applications to use manual corrections based on specific measurements rather than the factory-supplied data in the detector's PROM. This is known as "Cal Factor". (Some power meters on the market use the term "% efficiency", but it is basically the same thing.) Cal Factor is expressed in dB, and is the amount of power that must be added to or subtracted from the measurement so that the data will be correct.

Another "Data Modifier" called "Offset" can also be used. Complex microwave test setups sometimes include attenuators or couplers to reduce high power signals to safe levels that can be measured by delicate instruments such as the PPM. The Offset feature allows the "subtraction" of residual attenuator or coupler errors from the measurement.

The preceding Data Correction commands will be discussed in the following sections.

Detector PROM Correction: User Supplied Frequency

FREQff.ff

(Where ff.ff is the frequency of the correction.)

Correction is determined by taking user supplied frequency (ff.ff) and referencing data in a PROM in the detector.

Min Value: 0.01 GHz
Max Value: 110.00 GHz

Sample Program:

```
10    !  THIS PROGRAM SETS THE
20    !  FREQUENCY FOR DETECTOR
30    !  RESPONSE CORRECTION FOR
40    !  THE PPM
50    !
60    F=5.25  !  PPM FREQUENCY SETTING
70    !
80    !  SEND COMMAND TO PPM
90    OUTPUT 704 USING 100;"FREQ",F
100   IMAGE 4A,DDD.DD
110   END
```

Detector PROM Correction: External Frequency (V/GHz, Freq Ref)

FPRVvv.vv,ss.ss,mm.mm

(Where v, s, and m are the arguments required to scale the voltage input at the PPM's rear panel FREQUENCY INPUT connection.)

Correction to be applied for the frequency response of the detector will be determined from three user supplied values to properly reference data in the PROM in the detector. The three arguments are respectively:

(1) A coefficient representing the voltage proportional to frequency of the sweeper's V/GHz or Freq Ref output):

Min Value: 0.10V/GHz
Max Value: 10.00V/GHz

The most common values for this coefficient are 0.5 and 1.00V/GHz. Consult the manual for the sweeper being used to obtain the correct coefficient.

(2) The minimum coefficient voltage corresponding to the minimum frequency of the sweeper:

Min Value: 0.0V
Max Value: +19.000V

Example: If the sweeper's V/GHz is 0.5V and the minimum start frequency is 2.0 GHz, then this value would be 2 x 0.5 = 1V.

(3) The minimum frequency of the sweeper:

Min Value: 0 GHz
Max Value: 110.00 GHz

Sample Program:

```
10    !  PPM EXTERNAL FREQUENCY MODE
20    G=5  !  VOLTS/GHZ
30    V=1  !  V/GHZ START FREQUENCY
40    F=2  !  SWEEPER START FREQUENCY
50    OUTPUT 704 USING 60;"FPRV",G,V,F
60    IMAGE 4A,3(DD.DD)
70    END
```

External Frequency (V/GHZ) and Output Frequency To Controller Command

FPVOvv.vv,ss.ss,mm.mm

(Where V, S, and m are the arguments required to scale the voltage input at the PPM's rear panel FREQUENCY INPUT connection.) These are the same as described previously for FPRV.

This command causes the same action as the FPRV command but in addition, asks the PPM to output to the controller the converted frequency information from the PPM's rear panel external frequency input.

NOTE: When using FPVO and operating in the UPDC mode, there will be a stack build up. Old frequency and power data will be output in applications such as swept power measurements.

Sample Program:

```
10    !  PPM EXTERNAL FREQUENCY PLUS
20    !  FREQUENCY OUTPUT MODE
30    OUTPUT 704;"UPDT" ! SELECT OUTPUT
40    !  MODE. SELECT EXTERNAL FREQ
50    !  MODE AND COLLECT A DATA
60    !  POINT AND ITS FREQUENCY
70    G=5   !   VOLTS/GHZ
80    V=1   !   V/GHZ START FREQUENCY
90    F=2   !   SWEEPER START FREQUENCY
100   IMAGE 4A,3(DD.DD)
110   OUTPUT 704 USING 100;"FPVO",G,V,F
120   TRIGGER 704
130   ENTER 704 USING "4A,7D,X,4A,6D";A$,B,
      C$,D
140   PRINT USING "K,";"POWER ",A$," IS ",B
150   PRINT USING "K,";"FREQ ",C$," IS ",
      D," GHZ"
160   END
```

User Defined Detector Calibration Factor Commands

DCFAcc.cc

Detector calibration factor for channel A in dB (cc.cc):

Min Value: -9.99 dB
Max Value: +9.99 dB

DCFBcc.cc

Detector calibration factor for channel B in dB (cc.cc):

Min Value: -9.99 dB
Max Value: +9.99 dB

Sample Program:

```
10    !  THIS PROGRAM SHOWS HOW TO USE
20    !  THE PPM CAL FACTOR FEATURE
30    !
40    !  CHANNEL A CAL FACTOR
50    !  COMMAND FOR 2.56 dB:
60    OUTPUT 704;"DCFA";2.56
70    !
80    !  CHANNEL B CAL FACTOR
90    !  COMMAND FOR 2.56 dB
100   OUTPUT 704;"DCFB";2.56
110   !
120   END
```

Offsetting Measured Data: dB Offset Commands

OFFAsnn.nn

Channel A offset

(s = polarity;
nn.nn = dB value)

Min Value: -40.00 dB
Max Value: +90.00 dB

OFFBsnn.nn

Channel B offset

(s = polarity;
nn.nn = dB value.

Min Value: -40.00 dB
Max Value: +90.00 dB

Mode Selection and Control

This section describes the various modes of operation available with the PPM, with the exception of the sub-mode functions of the Graph Mode. These are described on page 4-16.

Commands or functions that affect a specific mode of operation are either given or referred to in the following command listings. It should be kept in mind that it is sometimes possible to combine modes, therefore care must be taken to observe the rules and arguments set forth. An example would be the Ratio Mode (available only on the Model 8502). With the PPM it is possible to ratio a CW signal to a Pulsed signal. It would be wise, therefore, to be sure that the rules for triggering under pulsed conditions are followed.

Data Normal Mode/Data Fast Mode Commands

DATF Enter the Data Fast Mode

DATN Enter the Data Normal Mode

All PPM commands and functions operate under the Data Normal Mode (DATN). The Data Fast Mode (DATF) of operation is provided to speed up GPIB operations. However, if the Data Fast Mode is used, the front panel display will display only "Fast Measurement Mode". No measurements will be displayed until the Data Normal Mode is re-entered.

Some rules to remember when using the Data Fast Mode are:

- No Graph Mode capability.
- No Linear Format capability.

It is not possible to enter the DATF mode while operating in the Graph Mode and/or Linear Format. Conversely, it is not possible to enter one of these modes while in the DATF mode.

The PPM's default mode of operation is the Data Normal Mode.

Select Log Or Linear Power Measurement Format Commands

DBMW	dBm measurement format display and GPIB output.
WATT	Linear measurement format (mW) display and GPIB output.

Typical Program Line: OUTPUT 704;"WATT"

Select Measurement Mode Commands

(Except Graph and Ratio Modes)

CW POWER COMMANDS

CWPA	CW power, channel A
CWPB	CW power, channel B
CWAB	CW power, channels A & B

A CW related command is:

AVCWnnn

Select number of averages n for CW power measurements. Higher numbers reduce noise effects and stabilize readings at low power levels.

(n = number between 1 and 999)

PEAK POWER COMMANDS

The Peak Power Mode must be used very carefully. Power measurements in this mode depend on the occurrence of a trigger, and the positioning of the cursor on the pulse to be measured. For more information, refer to Selecting Peak Power Operation on page 3-8 of the Operation chapter of this manual.

To enter the Peak Power Mode use:

PKPA	(Peak Mode for Channel A only)
PKPB	(Peak Mode for Channel B only)
PKAB	(Peak Mode for Channels A & B)

Related Peak Power Commands

AVPK Select number of averages, n, for Peak power measurements. Higher numbers will reduce noise effects and provide more stability at low power levels.

(n = number from 1 to 999 - higher than 4 is recommended).

TRGAsnn.nn

Internal trigger level, channel A

TRGBsnn.nn

Internal trigger level, channel B

(s = polarity; n = dBm)

Min Value: -10.00 dBm
Max Value: +16.00 dBm

TRGE External triggering

NOTE: It is important to remember that no data can be taken in the Peak Mode unless a trigger is occuring. This is indicated by the flashing of the "New Data" light on the front panel. See External Triggering on page 3-8 of this manual for description.

RDLAnnnnnn.nn

Set channel A reference delay. (Arbitrary timing point to which other timing measurements are related.)

(n = microseconds)

RDLBnnnnnn.nn

Set channel B reference delay. (Arbitrary timing point to which other timing measurements are related.)

(n = microseconds)

Min Value: 0 µs
Max Value: 213999.97 µs

CDLAsnnnnnn.nn

Set channel A cursor delay. Sets timing position of the Cursor on the graphic display. The Cursor is the vertical line located where the power reading (CSR PWR) is being taken. [Timing is related to the Reference Delay (REF DLY)].

(n = microseconds; s = polarity)

CDLBsnnnnnn.nn

Set cursor delay for channel B. Sets timing position of the Cursor on the graphic display. The Cursor is the vertical line located where the power reading (CSR PWR) is being taken. [Timing is relative to the Reference Delay (REF DLY)].

(n = microseconds; s = polarity)

Min Value: 0 - Reference Delay
Max Value: 213999.97 µs - Reference Delay

Sample Program:

```
10     D=1  !  CURSOR DELAY IN
20     !   MICROSECONDS
30     !
40     !   CHANGE CHANNEL A CURSOR
50     !   DELAY
60     OUTPUT 704;"CDLA";D
70     !
80     !   CHANGE CHANNEL B CURSOR
90     !   DELAY
100    OUTPUT 704;"CDLB";D
110    END
```

Ratio Mode Commands

(Model 8502A only)

The Ratio Mode can be used to measure the power ratio of two signals. These signals can be CW, pulsed, or a combination of both. Depending on whether the PPM is in the Linear (mW) or Log (dBm) mode, the instrument can output data in terms of dB or linear factor A/B expressed as "nnnnn-Esnn". The format for ratioing is always Chan A/ Chan B.

RTSM	To enter the Ratio Mode with both A and B channels selected.
ACBC	Select the ratio of channel A (CW) to channel B (CW)
ACBP	Select the ratio of channel A (CW) to channel B (Peak)
APBC	Select the ratio of channel A (Peak) to channel B (CW)
APBP	Select the ratio of channel A (Peak) to channel B (Peak)

NOTE: Remember that if the internal trigger function is being used, the channel that will provide the trigger must be specified and its level set. See Peak Power Commands on page 4-14.

Command for Retrieving Data from the PPM

UPDC	Select Update Data Continuously Mode. The PPM will output a continuous "stream" of power measurement data points separated by commas. Every time the PPM receives a trigger a new data point is added to the "stream". The formats to be discussed in the following two NOTES can then occur:

NOTE 1:

When using the FREQ, CALA (A Cal Factor), CALB (B Cal Factor), or FPRV (Rear Panel Frequency Input) methods for detector frequency response correction (NOT "FPVO"), the PPM's Linear Mode data output string for Channel A will be:

PWRAnn.nnEsnn,PWRAnn.nnEsnn,PWRAnn.nn
Esnn

(n = linear power in watts; Esnn = exponent)

This example shows a data string for 3 triggers. Subsequent triggers will produce more data points separated by commas in the form of "PWRAnn.nn-Esnn". If channel B is in use, the header before the data points would be "PWRB" instead of "PWRA".

The PPM's dBm mode data output string for channel A will be:

DBMAsnnn.nn,DBMAsnnn.nn,DBMAsnnn.nn

(s = polarity; n = dBm)

This example shows a data string for 3 triggers. Subsequent triggers will produce more data points separated by commas in the form of "DBMAnn.nn-Esnn". If channel B is in use, the header before the data points would be "DBMB" instead of "DBMA".

NOTE 2:

When using the FPVO (Rear Panel Frequency Input and Output Frequency) method for detector frequency reponse correction, the PPM's Linear Mode data output string for Channel A will be in the following form:

PWRAmm.mmEsee,FRQAfff.ffE+09,PWRAnn.nn
Esee,FRQAggg.ggE+09

(m = first power data point;
f = first frequency data point;
n = second power data point;
g = second frequency data point;
Esee = exponent for power in watts;
E+09 indicates frequency is in GHz.)

This example shows a data string for 2 triggers. Subsequent triggers will produce more data points separated by commas in the form of "PWRAnn.nn-Esnn,FRQAfff.ffE+09". If Channel B is being used, the headers before the data points would be "PWRB" and "FRQB". See NOTE 1, preceding, for the description of dBm header and data formats.

UPDT	Select Update Data Trigger Reset Output Mode. Prepares the PPM for power measurement data taking routines using UPDN.
UPDN	Update Data Now. Take a power reading when the next trigger occurs. This command is only operational if the PPM is in the Update Trigger Reset Mode. See UPDT.

The PPM will output a single data point each time "UPDN" is received. The output formats are the same as those described under UPDC. If FPVO is being used, the frequency at which the power measurement was taken is also output. See UPDC at the beginning of this section, and FPVO in NOTE 2.

Graph Mode GPIB Operation

Using the Graph Mode instead of the Peak Mode allows autoscaling of a pulse, and provides you with a display of the pulse. The Pulse and Marker sub-modes allow automatic timing measurements to be made. You must first place the PPM in the appropriate sub-mode before using the timing measurement command.

In the Graph Mode, the PPM can use a plotter to draw the shape of the pulse. In the Cursor sub-mode, the delay and trigger parameters are written on the plot. The Pulse and Marker sub-modes add the results of their respective timing measurements.

Delay values used by the instrument (Cursor, Start, and Marker, but not Window) are all displayed and output relative to the Reference Delay at the time the delays are specified. When the Reference Delay is chang-ed, it will effect all of the other indicated delay val-ues.

The real timing of the functions described above (relative to the trigger) remains the same, but the displayed and GPIB output times of these functions are all in relation to the Reference Delay. When the Reference Delay changes, the other delays change accordingly. For example, if the Cursor Delay was 5 ns and the Reference Delay was increased by 2 ns, the Cursor Delay would decrease to 3 ns. Therefore, Reference Delay entries should always be made first. Most applications and measurements will not require changing the Reference Delay from its default setting of 0.000 nanosecond.

The information to be given next is in ascending order of complexity. All functions that provide results on an automatic basis will be covered first. This should reduce programming time by allowing the PPM's internal software to take care of various tasks such as risetime.

Obviously, there are some types of pulses that cannot easily be measured automatically. If it is required that algorithms be devised to extract pulse information, the PPM should serve this purpose well by using the manual commands and functions which will be covered later in this section.

Graph Sub-Mode Selection Commands

GRFA	Select Graphic display mode (Cursor sub-mode), channel A.
GRFB	Select Graphic display mode (Cursor sub-mode), channel B.
MRKA	Select Marker sub-mode display, channel A.
MRKB	Select Marker sub-mode display, channel B.
PULA	Select Pulse Parameters sub-mode, channel A
PULB	Select Pulse Parameters sub-mode, channel B

NOTE: The Data Fast Mode has no graphic capability.

Automatic Functions Of Graph Mode

The following commands will instruct the PPM to automatically carry out a procedure of some kind. In most cases, only instrument settings are made. In some cases, settings are made and appropriate information is output to the controller.

When using the PPM's graphic capabilities, it should be kept in mind that any operations are only applicable to Pulse measurements. All pulse operations require a trigger of some kind. Therefore, before attempting GPIB operations it is advised to become familiar with the manual operation of the PPM. To ensure that the instrument will trigger properly, the Internal Channel A, Internal Channel B, or the External Trigger function must be selected.

Caution: Failure to trigger for any pulse operation over the GPIB will result in placing the PPM in a "Waiting for Trigger" state.

READING AND DEFINING PULSE PARAMETERS

The following commands are used to read the current values set for the pulse parameters: (The routine must be in the Pulse Parameters sub-mode.)

* PUFT Get Pulse Fall Time. (Operable only in Graph Mode.) The unit will respond with:

FALAdddddddE-e	(If channel A selected)
FALBdddddddE-e	(If channel B selected)

(d = seconds; e = exponent)

* PURT Get Pulse Rise Time. (Operable only in Graph Mode.) The unit will respond with:

RISAdddddddE-e	(If channel A selected)
RISBdddddddE-e	(If channel B selected)

(d = seconds: e = exponent)

* PUWD Get Pulse Width. (Operable only in Graph Mode.) The unit will respond with:

WIDAdddddddE-e	(If channel A selected)
WIDBdddddddE-e	(If channel B selected)

(d = seconds: e = exponent)

The following commands are used to set new values for the pulse parameters:

PUFSddd	Set Pulse Fall Time - Start %. Where: d = % expressed in 0.1% units. Allowable range is 1 to 999 (0.1% to 99.9%)
PUFEddd	Set Pulse Fall Time - End %. Where: d = % expressed in 0.1% units. Allowable range is 1 to 999 (0.1% to 99.9%)
PURSddd	Set Pulse Rise Time - Start %. Where: d = % expressed in 0.1% units. Allowable range is 1 to 999 (0.1% to 99.9%)
PUREddd	Set Pulse Rise Time - End %. Where: d = % expressed in 0.1% units. Allowable range is 1 to 999 (0.1% to 99.9%)
PUWSddd	Set Pulse Width - Start %. Where: d = % expressed in 0.1 units. Allowable range is 1 to 999 (0.1% to 99.9%)
PUWEddd	Set Pulse Width - End %. Where: d = % expressed in 0.1% units. Allowable range is 1 to 999 (0.1% to 99.9%)

AUTOMATIC WINDOW DELAY SELECTION RELATED COMMANDS (AUTOSCALING)

* AUTO	Autoscale Current Pulse Profile. If SRQ is enabled, it will be sent at the completion of Autoscaling. Successful Autoscaling can be determined by checking the value of the Status byte.

AVASnnn

Select the Number of Averages, n, for Autoscaling (1 to 999). This command can be useful when attempting to Autoscale a pulse in a "noisy" environment. The more stable the pulse to be Autoscaled is, the less averages required. This setting is independent of other averaging settings such as AVCW or AVPK.

Caution: The number of averages set by this command is never reset to a default value (not even by a Device Clear command). Therefore, it is advisable to set the desired value prior to commencing the Autoscaling function, or to set it once at the beginning of the program and not change its value again.

ASDLnnnnnn.n

Select Maximum Expected Pulse Width for Autoscaling. The purpose of this command is to allow autoscaling of narrow pulses with high repetition rates.

(n = 0.5 to 200,000 microseconds.)

Caution: The maximum expected pulse width set by this command is never reset to a default value (not even by a Device Clear command). Therefore, it is advisable to set this to the desired value prior to activating the Autoscale function.

Marker Timing Measurements

It must be kept in mind that a trigger must occur on a consistent basis in order to make repeatable pulse measurements for profiling operations. Erratic pulse trains or profiles can lead to errors or confusion. In situations where pulse widths or repetition rates are likely to continually vary, it would be better to make single pulse measurements in the Peak Mode. However, in order to make single pulse measurements, the user should have some idea of where the Cursor Delay should be set in order to make the measurement.

The commands given in the Automatic Timing description on page 4-19 allow for easy measurement of the most commonly desired pulse parameters. These include Risetime, Falltime, Pulse Width, and combinations thereof. The automatic measurements are determined by conventions commonly used in the microwave industry. For example, risetime would be from the 10% to 90% power points on the leading edge of the pulse. However, there are still some "gray" areas which the user must take into account when using these automatic timing functions.

These "gray" areas include deciding what point on the pulse should be considered as the 100% power reference point for the PPM to use when determining the risetime, falltime, and pulse width.

It is obvious that, in most situations, it is more desireable to use the center of the pulse as the reference point. Special situations can, of course, occur where the setting of the reference point would be somewhat arbitrary.

The PPM handles the above problems in two ways. The first method is when Autoscaling is used. The Reference Power level is automatically set to a point more or less centered in time between the 3 dB points on the pulse. The power axis of the display is also adjusted so that the point selected as the reference point is set to the top of the display as 100%.

The second method is to allow the user to set the Reference Power at some desired level. Power measurements can be taken at different points along the top of the pulse to find the optimum point at which to set the Reference Power. These decisions are based on the types of pulses it is expected will be encountered.

REFERENCE POWER RELATED COMMANDS

PRFAsnn.nn

Set Channel A Reference Power for graphic display. Sets 100% power reference point as a reference for automatic timing measurements. It also serves to center the pulse on the power axis so that displays and plots of pulses with low amplitudes are "expanded" to show more resolution.

(s = polarity; nn.nn = dBm value)

PRFBsnn.nn

Set Channel B Reference Power for graphic display. Sets the 100% power reference point as a reference for automatic timing measurements. It also serves to center the pulse on the power axis so that displays and plots of pulses with low amplitudes are "expanded" to show more resolution.

(s = polarity; nn.nn = dBm value)

Min Value: -60.00 dBm
Max Value: +110.00 dBm

Sample Program:

```
10    P=0   !  CHANNEL A REFERENCE
20    !  POWER IN DBM
30    !
40    !  CHANGE CHANNEL A REFERENCE
50    !  POWER
60    OUTPUT 704;"PRFA";P
70    !
80    !  CHANGE CHANNEL B REFERENCE
90    !  POWER
100   OUTPUT 704;"PRFB";P
110   END
```

RPOA Output Current Reference Power for Channel A. (Operable only in Graph Mode.) If the PPM is in the linear mode it will output:

RFALnn.nnEsnn

(nn.nn = Watts; Esnn = exponent)

If the PPM is in the dBm mode it will output:

RFADsnn.nn

(nn.nn = dBm; s = polarity)

RPOB Output Current Reference Power for Channel B. (Operable only in Graph Mode.) Linear mode output is:

RFBLnn.nnEsnn

(nn.nn = Watts; Esnn = exponent)

The dBm mode output is:

RFBDsnn.nn

(nn.nn = dBm; s = polarity)

AUTOMATIC TIMING MEASUREMENT COMMANDS

When making timing measurements, the delay window should be set so that the time to be measured corresponds to at least one third of the total delay. For example, do not use a delay window of 10 µs to measure risetimes faster than 3 µs; go to a shorter delay window. [Commands (except *WDFL) operable only in Graph Mode.]

* RISE Measure and Output Risetime of Displayed Pulse Profile. Risetime is from the 10% power point to the 90% power point on the rising edge of the pulse. Output format for channel A is:

RISAnn.nnnEsnn

(n = seconds; Esnn = exponent)

Output format for channel B is:

RISBnn.nnnEsnn

* FALL Measure and Output Falltime of Displayed Pulse Profile. Falltime is from the 90% power point to the 10% power point on the falling edge of the pulse. Output format for channel A is:

FALAnn.nnnEsnn

(n = seconds; Esnn = exponent)

Output format for channel B is:

FALBnn.nnnEsnn

* PLWD Measure and Output Pulse Width of Displayed Pulse Profile. Pulse width is the time between the 50% power points on the rising and falling edges of the pulse. Output format for channel A is:

WIDAnn.nnnEsnn

(n = seconds; Esnn = exponent)

Output format for channel B is:

WIDBnn.nnnEsnn

* RSFL Measure and Output Risetime and Falltime of Displayed Pulse Profile. For definitions, see RISE and FALL. Ch A output format is:

RISAnn.nnnEsnn,FALAnn.nnnEsnn

(n = seconds; Esnn = exponent)

Output format for channel B is:

RISBnn.nnnEsnn,FALBnn.nnnEsnn

* RSWD Measure and Output Risetime and Pulse Width of Displayed Pulse Profile. For definitions of risetime and pulse width, see RISE and FLWD descriptions. Output format for channel A is:

RISAnn.nnnEsnn,WIDAnn.nnnEsnn

(n = seconds; Esnn = exponent)

Output format for channel B is:

RISBnn.nnnEsnn,WIDBnn.nnnEsnn

* WDFL Measure and Output Pulse Width and Falltime of Displayed Pulse Profile. For definition of falltime and pulse width, see FALL and PLWD descriptions. Output format for channel A is:

WIDAnn.nnnEsnn,FALAnn.nnnEsnn

(n = seconds; Esnn = exponent)

Output format for channel B is:

WIDBnn.nnnEsnn,FALBnn.nnnEsnn

Manual Marker Placement/ Timing Measurement Commands

The PPM has a very forgiving command syntax which means that it is possible to send many commands in one string. For example, it is possible to use one string to place four different markers and then have the PPM output two pairs of delay differences.

Due to the upgrading of the software functions in the new 8500A instruments, some of the commands shown in this section will not be required when new code is written for the 8501A/8502A meters. The commands are left in this 8500A manual for those users who may have programs written for the old 8500 instruments, and want to cross-reference for the new 8500A instruments. If old code has been written for an 8500 instrument and includes some of these commands the program will still operate with the 8500A, but the commands will have no function. (The term "No Op" is used in the descriptions for these commands.) The commands that fall into this category will be defined.

It should be noted that the MRKA (or B) command must always be executed before any other marker bus commands will be accepted.

MKPRn,xx.x

Place Marker n (1 to 4) on the Rising Edge of the Pulse at the % Reference Power Defined by xx.x, and Output the Delay. The specified % reference must be between 0.1% and 99.9%. If channel A is in use, the PPM will output:

MRKAm,snn.nnnEsnn

If channel B is in use, the PPM will output:

MRKBm,snn.nnnEsnn

(m = marker number; s = polarity;
nn.nnn = delay in seconds; Esnn = exponent)

MKPFm,xx.x

Place marker n (1 to 4) on the Falling Edge of the Pulse at the Reference Power Defined by xx.x, and Output the Delay. The specified reference power must be between 0.1% and 99.9%. If channel A is in use, the PPM will output:

MRKAm,snn.nnnEsnn

For channel B, the output is:

MRKBm,snn.nnnEsnn

(m = marker number; s = polarity;
nn.nnn = delay in seconds;
Esnn = exponent)

NOTE: Due to the fact that markers are ***always*** *placed in the 8500A, the MKDF and MKPA commands described next will just take the latest computation and send it over the bus if they are included in the command string for the 8500A. The MKDF-1 command is a "No Op" command because markers are always placed.*

MKDFm,n

Place Marker Numbers m and n According to Their Previously Defined % Reference Powers and Positions on the Pulse Profile and Output the Difference between Their respective Delays. If channel A is in use, the PPM will output:

MDFA,m-n,nn.nnnEsnn

NOTE: If "-1" is used as the argument for MKDF, markers m and n must have been previously defined for automatic placement. Otherwise the default settings will be used. The defaults are:

M1 = 2.5%
M2 = 17.8%
M3 = 46.9%
M4 = 90%

If channel B is in use, the PPM will output:

MDFB,m-n,nn.nnnEsnn

(m = first marker number defined;
n = second marker number defined; nn.
nnn = the delay of m minus n in seconds;
Esnn = exponent)

MKPA Place all Four Markers According to Their Previously Defined % Reference Powers and Positions on the Pulse Profile and Output Their Respective Delays. For channel A, the output is:

MRKA1,snnn.nnEsnn;2,snnn.nnEsnn;3,snnn.nn Esnn;4,snnn.nnEsnn

If channel B is in use, the output is:

MRKB1,snnn.nnEsnn;2,snnn.nnEsnn;3,snnn.nn Esnn;4,snnn.nnEsnn

The numbers 1, 2, 3, & 4 represent the marker numbers to be used. The "snn. nnEsnn" following each marker number is the delay time of that marker with respect to the reference delay.

(s = polarity; nnn.nn = delay in seconds;
Esnn = exponent.
The arguments between each set of marker information are separated by a semi-colon.)

NOTE: If a marker number cannot be used for some reason or if the PPM could not place the marker, an SRQ will be generated and the marker will not be placed. Then the instrument will output a delay of 0.00 00E-99 seconds for that marker. If all markers are placed successfully, a service request will be generated and the status condition will be 31. If one or more markers are not placed for the reasons described above, then the status condition will be 37 after SRQ.

NOTE: Since markers are set at percentages of reference power and then the delay is computed by the 8500A instruments, the MKDA and MKDB commands described next are classed as "No Op" with the 8500A instruments.

MKDAm,snnnnnn.nn

Set Marker Number m to Desired Delay, n, in Microseconds on Channel A. (200,000 microseconds maximum)

MKDBm,snnnnnn.nn

Set Marker Number m to Desired Delay, n, in Microseconds on Channel B. (200,000 microseconds maximum)

NOTE: Since marker information is constantly being updated in the 8500A, the MKCA and MKCB commands described below are considered "No Op" with the 8500A instruments.

MKCAm Clear Marker Number m on Channel A.
MKCBm Clear Marker Number m on Channel B.

The preceding two commands clear both the current marker delay and any definition of automatic marker placement. In other words, they define the marker not to be placed.

Window and Cursor Control Commands

Some commands can be used in the Graph Mode as well as the Peak Mode of operation. Peak power measurements are made by placing the Cursor at the desired time point on the pulse to be measured. As previously mentioned, the Cursor Delay is with respect to the Reference Delay. Therefore, in the Peak Mode of operation, it is possible to set the Reference Delay and the Cursor Delay. These two commands are repeated here for use in the Graph Mode of operation.

Reference Delay is primarily used only in situations where a user wishes to pick an arbitrary point on the pulse as the reference to which all other timing measurements are to be made. One example might consist of a gaussian shaped TACAN radar pulse that is slightly distorted. It could be desired to make timing measurements with respect to the highest point on the pulse. It might also be desired to know the timing of the 3 dB point of the pulse with respect to its peak. When in doubt, the Reference Delay should be set to 0.0000 nanoseconds.

Besides the Reference Delay and Cursor Delay, the Start Delay and Window Delay can also be controlled. When the Reference Delay is 0, the Start Delay is the time between the occurence of a trigger and the beginning of the display of information on the PPM's graphic display. The Window Delay is the time "window" shown on the PPM display. By "expanding" or "contracting" the window, it is possible to view a wider or narrower pulse as desired. If Autoscaling is used, the PPM makes these settings automatically.

RDLAnnnnnn.nn

Set Channel A Reference Delay. (This is the arbitrary timing reference point that the user desires to use for referencing other timing measurements.)

(n = microseconds)

Min. Value:	0 µs
Max. Value:	213999.97 µs

RDLBnnnnnn.nn

Set Channel B Reference Delay. (This is the arbitrary reference point the user desires to use for referencing other timing measurements.)

(n = microseconds)

Min. Value:	0 µs
Max. Value:	213999.97 µs

CDLAsnnnnnn.nn

Set Cursor Delay for Channel A. Sets the timing position of the Cursor on the graphic display, or for Peak measurements. The Cursor is the vertical line on the display where the power reading (CSR PWR) is taken. (Timing is relative to the Reference Delay.)

(n = microseconds; s = polarity)

Min. Value:	0 - Reference Delay
Max. Value:	213999.97 µs - Reference Delay

CDLBsnnnnnn.nn

Set Cursor Delay for Channel B. Sets the timing position of the Cursor on the graphic display, or for Peak measurements. The Cursor is the vertical line on the display located where the power reading (CSR PWR) is taken. (Timing is relative to the Reference Delay.)

(n = microseconds; s = polarity)

Min. Value:	0 - Reference Delay
Max. Value:	213999.97 µs - Reference Delay

CDOA Output Current Channel A Cursor Delay. The PPM will output:

CDLAsnn.nnnEsnn

(s = polarity;
nn.nnn = delay in seconds;
Esnn = exponent)

CDOB Output Current Channel B Cursor Delay. The PPM will output:

CDLBsnn.nnnEsnn

(s = polarity;
nn.nnn = delay in seconds;
Esnn = exponent)

SDLAsnnnnnn.nn

Start Delay for Channel A. Sets timing position of left side of graphic display. (Timing is relative to the Reference Delay.)

(n = microseconds; s = polarity)

Min. Value:	0 - Reference Delay
Max. Value:	213999.97 µs - Window Delay - Reference Delay

SDLBsnnnnnn.nn

Start Delay for Channel B. Sets timing position of left hand side of graphic display. (Timing is relative to the Reference Delay.)

(n = microseconds; s = polarity)

Min. Value:	0 - Reference Delay
Max. Value:	213999.97 µs - Window Delay - Reference Delay

WDLAnnnnnn.nn

Delay Window for Channel A. Sets the amount of time from the left side to the right side of the graphic display.

WDLBnnnnnn.nn

Delay Window for Channel B. Sets the amount of time from the left to the right side of the graphic display.

(n = microseconds; s = exponent)

Min. Value:	12 ns
Max. Value:	213999.97 µs - Start Delay - Reference Delay

Commands To Output Graphic Data To A Controller

The PPM can be programmed to output data in several ways as described in the Output Modes discussion on page 4-3. When working with graphic displays it may be useful to enter the entire pulse profile into the controller. Once data has arrived at the controller, various operations programmed by the user can be conducted. For example, it could be desired to program the controller to calculate the peak to peak pulse flatness. The advantage of this method of data acquisition is that it is not necessary to go through the procedure of placing the cursor, taking a power reading, and then repeating the procedure until all points of interest are entered into the controller.

The PPM's graphic display (dump) capability allows the controller to use one command to fetch 118 data points along the pulse profile, as well as any pertinent timing settings relating to the profile being examined.

DUMG Output All 118 Power Measurement Points of the Displayed Pulse Profile. If channel A is in use, the PPM will output:

```
RDLAnn.nnnEsnn,
SDLAnn.nnnEsnn,
WDLAnn.nnnEsnn,
PWRAnnn.nnEsnn,nnn.nnEsnn, (repeats
until all 118 data points have been output)
```

(Esnn = exponent)

The PPM outputs the Reference Delay (RDLA) in seconds (nn.nnn), then the Start Delay (SDLA), and then the Window Delay (WDLA). This information is followed by the 118 power readings representing the pulse profile. All fields and data points are separated by commas. The "header" for the power readings is PWRA. The power readings take the form of "nnn.nnEsnn"; where nnn.nn is always in Watts, and Esnn is the exponent.

When the PPM outputs using channel B, the headers change to indicate B channel:

RDLB	SDLB
WDLB	PWRB

Commands Used For Plotting

As previously mentioned, there is very little reason to plot or conduct graphic operations in the Graph Mode. All of the operations conducted through the GPIB can be accomplished in the Marker Mode. (This is not completely true in the manual mode of operation.) Therefore, it is assumed that the PPM is in the Marker Mode of operation when executing any of the commands listed in this section for making hardcopy plots.

As described in the Stand Alone Plot Output Mode description on page 4-7, the PPM has two different plotting modes available. The "Stand Alone Plot" mode should not be used when the instrument is under the control of a remote controller. Also, the "Stand Alone Plot" mode should not be initiated from the front panel of the PPM when the instrument is under GPIB control. (See CAUTION on page 4-7.)

Before a plot is made, it might be desired to enter a part number or code number that can be used for reference. These commands are described in detail on page 4-6, and are included in summary in the following description.

PLCNaaaaaaaaaaaa

Set Code Number for plot to ASCII string represented by up to 12 characters (a).

PLPNbbbbbbbbbbbb

Set Part Number for plot to ASCII string represented by up to 12 characters (b).

PLOT Plot Pulse Profile Currently Displayed. Marker information will be plotted if the PPM is in the Marker sub-mode. Pulse information will be plotted if the PPM is in

	the Pulse sub-mode. See page 4-5 for details on using the PLOT command. There is also a sample progam on page 4-6 showing how to format the required "listen" and "talk" addressing procedures.
PLTT	This is the same as the PLOT command, but at a slower speed for transparency plots instead of paper plots.
PLTM	Change to Marker sub-mode, and then Plot.
PTTM	Same as PLTM, but at a slower speed for transparencies instead of paper plots.

NOTE: If it desired to save a plot on disk exactly as it would have been plotted by a digital plotter, the entire HPGL plot string can be entered into a variable in the GPIB controller using the following program:

```
10     DIM A$(CCCCC) !  NEED VARIABLE SIZE
20     !   HERE
30     OUTPUT 704;"PLOT"
40     ENTER 704;A$ ! ENTER PLOT HPGL
50     !   COMMANDS.
60     !   ADD PROGRAM LINES HERE TO
70     !   STORE A$
•
•
100    END
```

A$ can be recalled later from the disk file for plotting.

NOTE: When plots are output from the PPM, the pulse profile will always be in a linear format including when the reference power is labeled in dBm.

Programming Notes

The programming commands for the PPM can be strung together as long as the maximum length limitations specified in the General Information discussion are not exceeded.

This feature enables procedures to be formatted in a logical manner, and reduces the overall number of programming lines required. The following sample program shows how this can be done.

```
10     CLEAR 704  !  DEVICE CLEAR
20     OUTPUT 704;"ASDL200,AVAS25,AUTO"
30     OUTPUT 704;"PLCNabcdefg;PLPNqwerty;
40     RSFL,PLTM"
50     SEND 7;UNL
60     SEND 7;LISTEN 6
70     SEND 7;TALK 4
80     SEND 7;DATA
90     WAIT 180
100    SEND 7;UNT UNL
110    END
```

NOTES:

Line 20:	Sets the maximum pulse width for autoscaling to 200 microseconds; sets the averaging for autoscaling to 25 averages; instructs the PPM to autoscale.
Lines 30 & 40:	Sets the code numbers for the plot to "abcdefg"; sets the part number for the plot to "qwerty"; instructs the PPM to find the rise and fall times of the displayed pulse; instructs the PPM to place the markers as defined and to plot the displayed pulse profile.

The remaining lines in the sample program are used for bus handling.

Care should be exercised when grouping commands. If conflicting commands are sent in the same string, the last one to be received will be implemented. For example:

```
OUTPUT 704;"MRKA,CDLA5,PKPA"
```

This program line would result in the cursor delay being set at 5 µs, but the PPM would enter the channel A Peak Mode, not the Marker Mode as indicated by the MRKA portion. In other words, the PPM does not execute any of the commands until (CR) (LF) are received at the end of the program line.

Service Requests (& Serial Poll)

The ability of the PPM to request service over the GPIB can be enabled or disabled by a GPIB command. The PPM's power-on default status enables the SRQ function of the instrument. Usually a service request is generated to report a significant condition to the controller, and the status byte will not be cleared until it is read; REN is dis-asserted; or the instrument is reset. The exception to this is the output-ready condition which will also be cleared when the data is read. If SRQ is disabled the status bytes are not saved, but the current condition is available to be read using the STAT command (also see Output Modes and Command Descriptions on pages 4-3 and 4-9).

All SRQs are buffered in the PPM. If another error condition is detected after the first value has been read, then the SRQ will remain asserted with the second value in the status byte. Up to 16 status conditions can be buffered in this way. Once a non-zero condition is read from the PPM, the status byte should be read until it becomes zero by taking appropriate action. For example, if the error were overrange power, overrange SRQs will continue until the error is fixed.

When the controller reads the status byte through the GPIB via a serial poll, the 7th bit will always be high if the PPM was requesting service. Thus, the actual value of the PPM status will be the byte that is read minus the 7th bit. When the PPM's status is read by the STAT command (when SRQ is disabled), the byte that is sent out always has the 7th bit as zero (see Output Modes on page 4-3).

Any status condition that has the sixth bit high will indicate abnormal device operation. In decimal form, this is the case for any status code of value greater than or equal to 32.

Sample Program:

```
10    !  THIS PROGRAM USES SERIAL POLL
20    !  AND SRQ TO DETERMINE IF THE
30    !  PPM SUCCESSFULLY AUTOSCALED
40    !  AS INSTRUCTED.
50    !
60    A=0
70    !  ENABLE GPIB INTERRUPT
80    ON INTR 7 GOSUB 180
90    ENABLE INTR 7;2
100   !
110   !  ENABLE PPM SRQ
120   OUTPUT 704;"SRQE"
130   !  INSTRUCT PPM TO AUTOSCALE
140   OUTPUT 704;"AUTO"
150
160   !  SRQ WAIT LOOP
170   GOTO 160
180   !  SRQ HANDLING ROUTINE:
190   !  CONDUCT SERIAL POLL, AND
200   !  PUT STATUS BYTE VALUE IN
210   !  VARIABLE 'A'
220   A=SPOLL(704)
230   !  SUBTRACT 64 FROM STATUS
240   !  BYTE TO GET STATUS CODE
250   !  NUMBER CORRECT.  AUTOSCALING
260   !  RETURNS A CODE OF 27.
270   !
280   A=A-64
290   IF A=27 THEN GOTO 330
300   DISP "AUTOSCALING PROBLEM"
310   GOTO 340
320   RETURN
330   DISP "AUTOSCALING OK"
340   BEEP
350   END
```

Error Conditions

When it is first activated, the PPM will check to see if there has been a change in its internal software. An SRQ will be sent over the bus if any change is detected. The PPM will attempt to capture the PROM data from the detector(s), and will also check the detector's serial number(s) to see if there has been a detector change. The instrument will also detect a change in detectors that occurs at any time during a test and measurement operation. When detectors are changed, the instrument will request service and calibration will be required. No data can be taken over the GPIB until recalibration has been completed, or the detector has been removed or changed for the detector that was last calibrated.

If the instrument detects a power over range condition, it will send an SRQ. If data is being collected to be output over the bus, the data will still be available in memory and can be read out. However, if the power level was outside the PPM's normal range the data may not be accurate. This data may still give some idea of what power was being measured. If a serious overrange condition occured, detector damage may have resulted.

If an underrange condition occurs when the PPM is operating under bus control and it is not collecting data to be sent over the bus in the Update Data Trigger Reset, or Update Data Continuously Modes, then the instrument will not signal the controller (with a service request) that the under range condition has occured. Instead, the data display will display the standard under range message of "------". However, if the instrument is collecting data to send over the bus and the data is under range, then the PPM will request service (if SRQ is enabled) to report the condition if the user has asked for it to be reported. If the instrument is in the Update Data Trigger Reset Mode, the under range condition will be reported (via a serial poll) before the output ready condition. The data that will be output over the bus, if the data is still requested, will be an impossible value to indicate to the controller that an under range condition has occured and that the data is not valid. If the log (dBm) mode were in use, the instrument would output a reading of -999.99 dBm. In the linear mode, the reading will be 000.00E-99.

1018B Emulation

(Emulation of the 1018B instrument is accessed through the front panel. See Front Panel Menus on page 4-2.)

Differences in 1018B and 8501A/ 8502A Operation

The differences in the 1018B emulation mode to standard 8501A/8502A PPM operation are as follows:

Commands

The command set is limited to the three following 1018B commands:

?	Update data, behaves exactly as the UPDN PPM command
< nnn	Sets cursor delay to a value between 0 and 9.99 µs
> nnn	Sets cursor delay to a value between 0 and 99.9 µs

One to three digits are required, no sign or decimal point is allowed.

The instrument will only read the first 1018B command it receives and ignore the balance of any command string it receives. If the string does not start with a valid 1018B command, the instrument will ignore the entire string and take no action.

Output Data Modes

There are two output data modes in the 1018B Emulation Mode. These are Update Data Trigger Reset and Update Data Continuously. The default state upon entering the 1018B Emulation Mode is Update Trigger Reset. After that, the output mode can be changed from the front panel (see the Front Panel Menus description on page 4-2). The two modes work in exactly the same way as with the PPM except that the data output format is different.

Output Format

The data will always be output in a string consisting of a polarity sign, four digits, a comma, one last digit with a value of 0 - 3, a carrage return, and then a line feed character (all data lines low) sent with EOI. The first four digits represent the measurement., and the last digit after the comma indicates the range.

Range	Data Format
0	SNNN.N dBm
1	SNNN.N microwatts
2	SNN.NNN milliwatts
3	SN.NNN milliwatts

NOTE: The sign will always be positive for linear values.

Examples:

-0147.0(CR)(LF)(NULL - EOI) = -14.7 dBm

+1257.3(CR)(LF)(NULL - EOI) = +1.257 mW

In the Update Continuously Mode, a continuous string of these measurements will be sent, including the terminating characters, until the PPM is untalked.

Remote

As in the regular PPM operation mode, the instrument must be in the REMOTE state to accept any commands over the GPIB or to output any data. However, unlike the standard PPM operation, the front panel is fully active while in the REMOTE state and more Menu options will become active in 1018B emulation (see the Front Panel Menus discussion on this page). This imposes two requirements for the operator. One is the fact that a cursor delay will be accepted on either the front panel or over the GPIB. The most recent cursor delay will be used to determine the measurement. The other difficulty is that a measurement and not a menu prompt must be displayed on the screen for the instrument to be able to collect data. If the controller tries to collect data while the PPM has a front panel menu displayed, the PPM will take no action until it returns to displaying data on the front panel. Then it will collect and output the data. Also, there is no return to local escape sequence while in REMOTE since the front panel is not locked out. There is no local lockout feature either.

Serial Poll

The serial poll feature operates similar to the 1018B serial poll function. The only time SRQ is asserted is if an output is ready and the value of the status byte is zero.

Front Panel Menus

The front panel menu will include three options regarding GPIB control when in the 1018B emulation mode. These options represent capabilities which can be set on the 1018B front panel, but not on the PPM in general usage. This is because each of these options are directly controllable over the GPIB in normal PPM usage.

Disable/Enable SRQ:

> This allows the SRQ capability to be enabled or disabled with the same effects as the SRQE and SRQD PPM GPIB commands. Whatever option is offered, enable or disable, will be the opposite of the current state.

Update on Trigger Reset/Continuous:

> This sets the Output Mode. The choice offered will be the opposite of the current mode. Upon entering the 1018B emulation mode, the Output Mode will be set to Update on Trigger Reset.

End 1018B Emulation Mode:

> This prompt will replace the menu prompt that initiated the 1018B Emulation Mode.

Analog Output

When using the PPM in the 1018B Emulation Mode, it should be kept in mind that the 1018B instrument has a 10 mV/dB Analog Output while the PPM has 100 mV/dB. If the 10mV/dB output of the 1018B is required, a 10:1 resistive "L" attenuator can be placed on the PPM's output.

Notes on Operation in the 1018B Emulation Mode

Two Detectors

The Model 8502A has two detectors instead of only one as does the 1018B. When in the 1018B Emulation Mode, either detector can be used with the choice made through the front panel. It is up to the operator to know which detector is active when the command is given over the GPIB to change cursor delay or to take a measurement. If both detectors are active, the instrument will ignore any GPIB commands and not be able to output any data.

Reference Delay, Correction of Carrier Frequency, and Offset vs 1018B Direct Mode

A correction will always be made on the carrier frequency. However, to simulate the 1018B direct mode if desired, the reference delay and offset features of the PPM can be negated by setting both to zero via the front panel.

Over and Under Range Conditions

The maximum value that the 1018B can output is 19.99 mW. Any power reading over that will just result in a reading of 19.99 mW when in the linear mode. In the log mode, the reading could be displayed up to 099.99 dBm. The minimum values are 000.0 µW in the linear mode or a reading of -099.9 dBm indicating an under range condition in the log mode.

1018B Features not Emulated by the PPM

Following is a list of the differences in GPIB operation when the Model 1018B Peak Power Meter is replaced on the bus with a Model 8501A or Model 8502A Peak Power Meter (PPM):

1. The PPM has no ability to be directly triggered with a GET command. It can only reset its trigger to capture the next pulse that will trigger the instrument.

2. The PPM has no talk only mode.

3. Whereas the 1018B allowed completely independent talk and listen addresses, the PPM must have the same talk and listen addresses. The addresses are set as one via the front panel.

4. The 1018B locks out the front panel delay setting capability while in the REMOTE state. The front panel delay setting ability remains active on the PPM when in the REMOTE state of the 1018B Emulation Mode.

5. The 1018B will take commands and output data even if it is not in the REMOTE state. This requires the instrument to be in REM.

Status Code Decimal Values

The decimal values of the various status codes minus the 7th bit are as follows:

NOTE: To determine the value with the 7th bit high, add 64 to the values listed below.

Status Code Values with Conditions

0	Operation normal, no condition to report.
1	Output ready to be sent over GPIB.
10	Self test passed.
20	Calibration passed.
25	Autozero passed.
27	Autoscaling completed and passed.
31	If RISE, PLWD, FALL, RSFL, RSWD, WDFL, PUFT, PURT, OR PUWD all measurements successfully made.
33	Command string syntax error, command(s) not processed.
34	Command string has invalid argument, command(s) not processed.
35	Command string(s) incomplete when unlistened, string(s) sent so far are lost, command(s) not processed.
36	PPM command buffer overflow. Limit of 128 character string exceeded. String lost, no commands processed.
37	Cannot execute MKDF, markers to be measured are undefined. No command(s) processed,
38	Command not executed, PPM not in REMOTE state.
39	Command not implemented, no commands processed.
40	GET sent when not in REMOTE.
41	GET or UPDN command sent when not in the Update Data Trigger Reset Output Mode. If UPDN command, no command(s) processed.
43	Not in Graph Mode or Marker sub-mode, must be in Graph Mode for AUTO (Autoscale Graph), or PLOT commands to function. Must be in Marker sub-mode for marker commands to function. No command(s) processed.
44	Autoscaling, PLOT, DUMG, pulse parameter, or a marker placement command has been specified in the command string and a mode change requested later at some point in the same command string. Mode change not processed.
45	STAT command sent while SRQ enabled, STAT command not active.
46	SRQ buffer overflow, SRQ enabled and not being read quickly enough by the controller.
48	Cannot enter Fast Measurement Mode. Either in linear, graph, or marker mode. No command(s) processed.
49	Cannot execute RECL or WATT commands, or any graph or marker commands in the Fast Measurement Mode. No command(s) processed.
50	Error in reading PROM data from detector A.
51	Error in reading PROM data from detector B.
52	Calibration aborted for lack of a detector.
53	Calibration passed, but with PROM read error.
54	Calibration failed with PROM read error.
55	Calibration failed.
57	Autozero aborted for lack of detector.
58	Autozero fail.
59	Autoscaling aborted for lack of detector.
60	Autoscaling interrupted by GPIB bus command, no trigger received.

61	Unable to Autoscale.
63	Unable to place markers specified or required to make a pulse parameter measurement.
170	Self test failed. (See Self Test Failure Indications on page 7-12 of the Maintenance chapter of this manual for description and possible causes pertaining to Error Numbers 01 through 11. These will be decimal values 170 through 180, respectively.)
184	New software detected. Must recalibrate both detectors.
185	Serial numbers don't match. Must recalibrate A and B detectors.
186	Serial number doesn't match. Must recalibrate detector A.
187	Serial number doesn't match. Must recalibrate detector B.
189	Instrument operation failure. PPM will probably need to be reset.
190	Under range. Measurement not accurate.
191	Over range. Damage to instrument may have occurred.

Summary of Bus Functions

Normal PPM Operation (Under GPIB Control)

SH1	Complete source handshake capability.
AH1	Complete acceptor handshake capability.
T6	Basic talker and serial poll capability, unaddressed as a talker if listen addressed, no talk only mode.
TE0	No talk address extension capability.
L4	Basic listener capability, unaddressed as a listener if talk addressed, no listen only mode.
LE0	No listen address extension capability.
SR1	Complete service request capability (when SRQ enabled).
RL1	Complete remote local interface capability with local lockout capability.
PP0	No parallel poll capability.
DC1	Complete device clear capability [responds to device clear (DCL) and selective device clear (SDC)].
DT1	Complete device trigger capability [responds to group execute trigger, GET (see Update Trigger Reset, on page 4-4)].
C0	No controller capability.

PPM Stand Alone Plot Operation

When the PPM is in the Stand Alone Plot mode, two functions will exhibit different capabilities. The Talker and Controller functions are redefined as follows:

T5	Same as T6 capability previously described except it has talk only capability used while plotting.
C1, C3, & C28	System controller capability with the ability to send REN and interface messages, but with no capability to send IFC, respond to SRQ, conduct parallel poll, or pass control.

Command Summary:

(Alphabetical Listing)

The command summary listings given in this section will be in the following format:

ABCDn . . . . n

Description/PPM output strings.

(n = units; limits)

When arguments are not required, the argument column is blank. If the command is not intended to make the PPM output a data string, the output string will say "none". Arguments are represented by lower case characters, while commands and output string "headers" (always four characters) are capitalized. The position of the decimal point can vary in Delay commands.

Commands that are underlined indicate that the command cannot be used while in the Data Fast (DATF) Mode.

ACBC Select Ratio Mode - Channel A (CW) to Channel B (CW) / none

ACBP Select Ratio Mode - Channel A (CW) to Channel B (Peak) / none

APBC Select Ratio Mode - Channel A (Peak) to Channel B (CW) / none

APBP Select Ratio Mode - Channel A (Peak) to Channel B (Peak) / none

ASDLnnnnnn.nn

Select Initial Delay Used for Autoscaling Pulse Profile / none

(n = microseconds; 200,000 maximum)

AUTO Autoscale Current Pulse Profile / none

AVASnnn

Select Averaging Value Used for Autoscaling Pulse Profile / none

(n = 1 to 999)

AVCWnnn

Select Number of Averages for CW Power Measurement / none

(n = 1 to 999)

AVPKnnn

Select Number of Averages for Peak Power Measurement / none

(n = 1 to 999)

CALA Calibrate Channel A Detector. Takes time to complete - SRQ can be used to monitor successful (or unsuccessful) completion / none

CALB Calibrate Channel B Detector. Takes time to complete - SRQ can be used to monitor successful (or unsuccessful) completion / none

CDLAnnnnnn.nn

Set Channel A Cursor Delay / none

(n = microseconds; 213,999.97 - Ref Dly maximum; 0 - Ref Dly minimum) Position of decimal point may vary. Cursor Delay is in respect to the Reference Delay. If Reference Delay = 0, then the Cursor Delay is with respect to the trigger.

CDLBnnnnnn.nn

Set Channel B Cursor Delay / none

(See CDLA)

CDOA Read Out Current Channel A Cursor Delay / PPM will output:

CDLAsnn.nnnEsnn

(s = polarity;
n = Cursor Delay in seconds (decimal point may shift);
Esnn = exponent value in eng. notation

CDOB Read Out Current Channel B Cursor Delay / PPM will output:

CDLBsnn.nnnEsnn

(See CDOA)

CWAB Select Dual Channel Mode: CW Both Channels / none

CWPA Select Channel A Only: CW Power / none

CWPB Select Channel B only: CW Power / none

DATF Select Data Fast Operation (No EL Display) / none

NOTE: Graph, Marker, or Linear Power Modes cannot be used while operating in DATF. Conversely, DATF cannot be used while in the Graph, Marker, or Linear Power Modes. Do not use commands related to these modes when the DATF function is in use.

DATN Select Data Normal Operation (Exit Data Fast) / none

DBMW Select dBm Power Format / none

DCFAc.cc

Select Channel A Cal Factor / none

(c.cc = Cal Factor; -9.99dB min,
+9.99 dB max)

DCFBc.cc

Select Channel B Cal Factor / none

(See DCFA)

DTMP Read Out Temperature Difference of Detectors Since Last Calibration / PPM will output:

DTPAsxx.x, DTPBsyy.y

DUMG Graphic Display - Read Out Reference Delay, Start Delay, Window Delay, and 118 Displayed Data Points of Current Pulse Profile / When PPM is displaying channel A, it will output:

RDLAnn.nnnEsnn,SDLAnn.nnnEsnn,
WDLAnn.nnnEsnn,PWRApp.ppEspp,pp.pp
Espp . . . .

(Ref. Dly, Strt. Dly, Wind Dly, Power - 118 points separated by commas. Delays (n) are in seconds; Powers are always in Watts)

FALL Measure and Output Fall Time of Displayed Pulse Profile (90% to 10% on the falling edge of the pulse profile. This command erases previously set markers. The PPM will output the following string when operating in channel A:

FALAnn.nnnEsnn

For channel B:

FALBnn.nnnEsnn

(n = seconds;
Esnn = exponent;
s = polarity)

FPRVvv.vv,ss.ss,mm.mm

Select External Frequency Input Mode. Sweeper Connected to Rear Panel Input Determines Detector Frequency Response Correction / none

(v = volts/GHz; 0.1 to 10.00;
s = Start Voltage; 0 to 19.00;
m = Start Frequency; 0 to 110.00GHz)

FPVOvv.vv,ss.ss,mm.mm

Select "FPVO" mode. i.e. Selects the External Frequency input mode and causes output of current operating RF frequency with each power measurement taken while using UPDN or UPDC / none

(See FPRV)

FQDS Enable (Unhide) Frequency Information Display on PPM Front Panel / none

FQHD Disable (Hide) Frequency Information Display on PPM Front Panel / none

FREQff.ff

Select Frequency for Detector Frequency Correction / none

(f = frequency; 0.01 to 110.00GHz)

GREA Select Graph Mode - Channel A / none

GREB Select Graph Mode - Channel B / none

MAXPsnn.nn

Set Power for Overrange Condition / none

(s = polarity;
n = power in dBm; +21.00 max, -10.00 min)

MINPsnn.nn

Set Power for Underrange Condition / none

(s = polarity;
n = power in dBm; -15.00 max, -50.00 min)

NOTE: Some of the following marker commands are no longer necessary when writing code pertaining to markers for the 8500A instruments. See the Manual Marker Placement section starting on page 4--20.

MKCAn ("No Op" command with the 8500A)

Clear Marker Number Selected on Channel A / none

(n = marker number to clear; 1 to 4)

MKCBn ("No Op" with the 8500A)

Clear Marker Number Selected on Channel B / none

(n = marker number to clear; 1 to 4)

MKDAn.dddddd.dd ("No Op" with the 8500A)

Select Channel A Marker Delay number n, and set it's delay to d / none

(n = marker number to clear; 1 to 4;
d = marker delay in microseconds;
200,000 max)

MKDBn.dddddd.dd ("No Op" with the 8500A)

Select Channel B Marker Delay number n, and set it's delay to d / none

(See MKDA)

MKDFa.b

Place Markers (a and b) which were previously selected, and Output Their Delay Difference (a - b). Marker differences can also be deselected - See MKDF-1 / When the PPM is in channel A, it will output:

MDFA,a-b,nn.nnnEsnn

(a = first marker; b = second marker; result will be the marker "a" delay minus the marker "b" delay)

MKDF-1 ("No Op" with the 8500A)

Deselect all Marker Difference Pairs / none

MKPA

Autoplace All Four Markers as previously selected and Output Their Delays / If the PPM is in channel A it will output:

MRKA1,nn.nnnEsnn;2,nn.nnnEsnn;
3,nn.nnnEsnn;4,nn.nnnEsnn

If the PPM is in channel B, it will output the same as above only with MRKB header.

(1, 2, 3, and 4 = marker numbers;
n = delay in seconds;
Esnn = exponent)

MKPFa.xx.x

Place Given Marker on Falling Slope of Pulse Profile at the Selected % Power Reference, and Output Its Delay / When the PPM is in channel A, it will output:

MRKAa,nn.nnnEsnn

When the PPM is in channel B, it will output:

MRKBa,nn.nnnEsnn

(a = marker number; 1 to 4;
x = percent of reference power to place marker; 0.1% min, 99.9% max;
n = delay in seconds; Esnn = exponent)

MKPRa.xx.x

Place Given Marker on Rising Slope of Pulse Profile at the Selected % Power Reference, and Output Its Delay / When in channel A, the PPM will output:

MRKAa,nn.nnnEsnn

When in channel B, the PPM will output:

MRKBa,nn.nnnEsnn

(See MKPF)

MRKA Select Channel A Marker Sub-Mode / none

MRKB Select Channel B Marker Sub-Mode / none

OFFAsnn.nn

Set Channel A Offset / none

(s = polarity;
n = dB offset; -40.00 min, +90.00 max)

OFFBsnn.nn

Set Channel B Offset / none

(See OFFA)

FALL	Returns value of fall time, rise time, pulse width, and peak power. (This command on the GPIB for Channel A and Channel B returns as a continuous, comma separated, series of values and mnemonics.) For Channel A: FALA+0022.9E-09, RISA+0013.0E-09 WIDA+0749.5E-09, PKRA+015.57 For Channel B: FALB+0023.4E-09, RISB+0012.5E-09 WIDB+0748.2E-09, PKRB+015.62
PKAB	Select Dual Channel Mode: Peak Power Both Channels / none
PKPA	Select Channel A Only: Peak Power Mode / none
PKPB	Select Channel B Only: Peak Power Mode / none
PLCNx	Set Code Number to be Plotted / none (x = ASCII string of 12 characters or less)
PLOT	Plot Pulse Profile Currently Displayed GPIB interface must be managed correctly. PPM will output pulse profiles with relevent marker information (or without if desired) using HPGL graphics codes to a compatible digital plotter. See page 4-5 for plotting instructions.
PLPNx	Set Part Number to be Plotted / none (x = ASCII string of 12 characters or less)
PLTM	Change to Marker Sub-Mode and immediately begin plotting / See PLOT. (This command ensures that the placement of markers is based on the same power measurement data as is sent to the plotter for increased accuracy of marker placement(s) on the hardcopy plot.)
PLTT	Plot Pulse Profile Currently Displayed at Slower Speed for Transparencies / Same as PLOT, but slower pen speed.
PLWD	Measure and Output Pulse Width of Pulse Profile Currently Displayed (50% point on rising edge of pulse to 50% point on the falling edge of the pulse). This command erases previously set markers / The PPM will output the following string when operating in channel A: WIDAnn.nnnEsnn For channel B: WIDBnn.nnnEsnn
PRFAsnn.nn	Set Channel A Reference Power for Graphic Display / none (s = polarity; n = dBm value; +110.00 max, -60.00 min)
PRFBsnn.nn	Set Channel B Reference Power for Graphic Display (s = polarity; n = dBm value; +110.00 max, -60.00 min)
PTTM	Change to Marker Sub-Mode and plot at Slower Speed for Transparencies / Same as PLTT, but with slower pen speed.
PUFE	Set Pulse Fall Time - End % / none [n = % expressed in 0.1% units; 1 to 999 (0.1% to 99.9%)]
PUFS	Set Pulse Fall Time - Start % / none [n = % expressed in 0.1% units; 1 to 999 (0.1% to 99.9%)]
PUFT	Measure and Output Falltime of Pulse Profile displayed in the Pulse Parameters sub-mode. / The PPM will output the following string when operating in Channel A: FALAnnnnn.nEsnn For Channel B:

FALBnnnnn.nEsnn

(n = seconds;
Esnn = exponent;
s = polarity)

PULA Select Channel A only: Pulse Parameter sub-mode / none

PULB Select Channel B only: Pulse Parameter sub-mode / none

PURE Set Pulse Rise Time - End % / none

[n = % expressed in 0.1% units; 1 to 999 (0.1% to 99.9%)]

PURS Set Pulse Rise Time - Start & / none

[n = % expressed in 0.1% units; 1 to 999 (0.1% to 99.9%)]

PURT Measure and Output Risetime of Pulse Profile Displayed in the Pulse Parameters sub-mode. / The PPM will output the following string when operating in Channel A:

RISAnnnnn.nEsnn

(n = seconds; Esnn = exponent; s = polarity)

For Channel B:

RISBnnnnn.nEsnn

(n = seconds; Esnn = exponent; s = polarity)

PUWD Measure and Output Pulse Width of Pulse Profile Displayed in the Pulse Parameters sub-mode. / The PPM will output the following string when operating in Channel A:

WIDAnnnnn.nEsnn

For Channel B:

WIDBnnnnn.nEsnn

(n = seconds; Esnn = exponent; s = polarity)

PUWE Set Pulse Width - End % / none

[n = % expressed in 0.1% units; 1 to 999 (0.1% to 99.9%)]

PUWS Set Pulse Width - Start % / none

[n = % expressed in 0.1% units; 1 to 999 (0.1% to 99.9%)]

RDLAnnnnnn.nn

Set Channel A Reference Delay / none

RDLBnnnnnn.nn

Set Channel B Reference Delay / none
(n = microseconds; 213,999.97 max)

RECLnn

Recall Non-Volatile Set Memory Number n / none
(n = memory location; 0 to 10; 0 is the last setup before device clear or power off. The remainder are user memories in which setups can be stored from the front panel, or see STOR command)

RISE Measure and Output Risetime of Pulse Profile Currently Displayed (10% to 90% on the rising edge of the profile). This command erases previously set markers / The PPM will output the following string when operating in channel A:

RISAnn.nnnEsnn

For channel B:

RISBnn.nnnEsnn

(n = seconds;
Esnn = exponent;
s = polarity)

RPOA Read Out Current Channel A Reference Power / The PPM will output channel A reference power in the following format: If operating in the Linear Power Mode:

RFALxx.xxEsnn
(x = power in Watts; Esnn = exponent)

If operating in the dBm power format:

RFADsnnn.nn

(s = polarity; n = reference power in dBm)

RPOB Read Out Current Channel B Reference Power. (Readout is the same as RPOA, substituting "B" for "A".)

RSFL Measure and Output Rise and Fall Times of Pulse Profile Currently Displayed. See FALL and RISE for definitions used for fall and risetimes / When operating in channel A, the PPM will output:

RISAnn.nnnEsnn,FALAnn.nnnEsnn

When operating in channel B:

RISBnn.nnnEsnn,FALBnn.nnnEsnn

(n = delay in seconds; Esnn = exponent)

RSWD Measure and Output Risetime and Pulse Width of Pulse Profile Currently Displayed. See RISE for definition of risetime. Pulse width is the time between the 50% power point on the pulse's rising edge, and the 50% point on it's falling edge / Channel A readout is:

RISAnn.nnnEsnn,WIDAnn.nnnEsnn

Channel B readout is:

RISBnn.nnnEsnn,WIDBnn.nnnEsnn

SDLAnnnnnn.nn

Set Channel A Start Delay / none

(n = microseconds; position of decimal may vary.
Max = 213,999.97 µs - Window Delay - Reference Delay;
Min = 0 - Reference Delay.
Start Delay is with respect to the Reference Delay. If Reference Delay is 0, then Start Delay is coincident with the trigger.)

SDLBnnnnnn.nn

Set Channel B Start Delay / none

(See SDLA)

SELT Initiate Self Test. Can be used with SRQ for a health check. See Service Requests on page 4-24 for description.

SRQD SRQ Disable. See Service Requests.

SRQE SRQ Enable. See Service Requests.

STAT Output Status Byte. This command is only effective when SRQ is disabled. If sent while SRQ is enabled, an SRQ will be generated. The PPM will output:

STATnnn

(n = decimal number representing current Status Byte. See Status Byte Output on page 4-7 and Service Requests on page 4-25.)

STORnn Store Current PPM Settings in Non-Volatile Set-Up Memory Number n / none

(n = number between 1 and 10)

TRGAsnn.nn

Select Channel A Internal Trigger and Set Level in dBm / none

(s = polarity;
n = trigger level - +16 dBm max,
-20 dBm min)

TRGBsnn.nn

Select Channel B Internal Trigger and Set Level in dBm / none

(See TRGA)

TRGE Select External Trigger Mode / none

UNDD Disable PPM SRQ for Underrange Conditions. See Service Requests on page 4-25 for more information / none

UNDE Enable PPM SRQ for Underrange Conditions. An SRQ will be generated if the power level measurement data is below the level set by MINP / none

UPDC Select Update Data Continuously Output Mode. The PPM will output a continuous "stream" of power measurement data points separated by commas. Every time the PPM receives a trigger, a new data point is added to the stream. The formats described below can occur.

NOTE 1:

When using the FREQ, DCFA (A Cal Factor), DCFB (B Cal Factor), or FPRV (Rear Panel Frequency Input) methods for detector frequency response correction, the PPM's Linear Mode data output string for channel A will be:

PWRAnn.nnEsnn,PWRAnn.nnEsnn,PWRAnn.nnEs
nn
(n = linear power in Watts; Esnn = exponent)

This example shows a data string for 3 triggers. Subsequent triggers will produce more data points separated by commas in the form of "PWRAnn.nnEsnn". For channel B, the header before the data points would be "PRWB" instead of "PWRA".

The PPM's dBm Mode output for channel A would be:

DBMAsnnn.nn,DBMAsnnn.nn,DBMAsnnn.nn
(s = polarity; n = dBm)

This example shows a data stream for 3 triggers. Subsequent triggers will produce more data points separated by commas in the form of "DBMAsnn.nn". For channel B, the header before the data points would be "DBMB" instead of "BDMA".

NOTE 2:

When using the FPVO (Rear Panel Frequency Input and Output) method for detector frequency response correction, the PPM's Linear Mode data output string for channel A will be in the form:

PWRAmm.mmEsee,FRQAfff.ffE+09,PWRAnn.nnE
see,FRQAggg.ggE+09

(m = first power data point;
f = first frequency data point;
n = second power data point;
g = second frequency data point;
Esee = exponent for power in Watts;
E+09 indicates frequency is in GHz)

This example shows a data stream for 2 triggers. Subsequent triggers will produce more data points separated by commas in the form of "PWRAnn.nn Esnn,FRQAfff.ffE+09". If the PPM is in channel B, the headers before the data points would be "PWRB" and "FRQB". See NOTE 1, preceding, for description of dBm header and data formats.

UPDN	Update Data Now. i.e: Take a power reading when the next trigger occurs. This command is only operational if the PPM is in the Update Trigger Reset Mode. See UPDT. / The PPM will output a single data point each time "UPDN" is received. The output formats are the same as those described under UPDC except that each data point is not followed by a comma. Instead, each point is followed by a carriage return followed by a line feed sent with EOI. If FPVO is being used, the frequency at which a power measurement was taken is output also. See UPDC and FPVO.
UPDT	Select Update Date Trigger Reset Output Mode. Prepares the PPM to take power readings using UPDN or GET / none
WATT	Select Linear Power Format / none
WDFL	Measure and Output Pulse Width and Falltimes of Pulse Profile Currently Displayed. See FALL for definition of falltime. Pulse width is the time between the 50% point on the pulse's rising edge and the 50% point on it's falling edge / When operating in channel A, the PPM will output: WIDAnn.nnnEsnn,FALAnn.nnnEsnn For channel B, the output is: WIDBnn.nnnEsnn,FALBnn.nnnEsnn (n = delay in seconds; Esnn = exponent)
WDLAnnnnnn.nn	Set Channel A Delay Window / none (n = microseconds; position of decimal point may vary. 0.012 µs min; 213,999.97 - Start Delay - Reference Delay max)
WDLBnnnnnn.nn	Set Channel B Delay Window / none (See WDLA)
ZERA	Autozero Channel A Detector. Takes time to complete - SRQ can be used to monitor successful (or unsuccessful) completion / none

ZERB Autozero Channel B Detector. Takes time to complete - SRQ can be used to monitor successful (or unsuccessful) completion / none

*IDN? Identification Query - Output Model; Software Version. The PPM will output:

WMI,8501A,0,VERnn.nn

(WMI = Wavetek Microwave, Inc.;
8501A = model number;
0 = N/A;
VER = software version;
n = number of the software version. If using a Model 8502A, "8501A" would be replaced by "8502A")

1018B Emulation Commands

< NNN Set Delay 0 to 9.99 microseconds (1018B Emulation) / none

(nnn = delay in hundredths of microseconds)

NOTE: A decimal point cannot be sent in the argument string.

NNN Set Delay 0 to 99.9 microseconds (1018B Emulation) / none

(nnn = delay in tenths of microseconds.)

NOTE: A decimal point cannot be sent in the argument string.

? Update Data (1018B Emulation).

Causes a trigger reset when in the "update" or "trigger" modes. The PPM will output power measurement data the next time a trigger occurs.

Data Formats

Data will be in the following formats:

dBm Mode:

snnnn,0(CR)(LF)(NULL EOI)

(Interpret snnnn,0 as nnn.n dBm)

Range 1: (microwatts)

snnnn,1(CR)(LF)(NULL EOI)

(Interpret snnnn,1 as nnn.n uW)

Range 2: (milliwatts)

snnnn,2(CR)(LF)(NULL EOI)

(Interpret snnnn,2 as nn.nn mW)

Range 3: (milliwatts)

snnnn,3(CR)(LF)(NULL EOI)

(Interpret snnnn,3 as n.nnn mW)

(s = polarity; linear always +;
n = power value)

NOTE: When operating in the Linear Mode, the range is determined from the linear range that has been set from the front panel.

CHAPTER 5

ELECTRICAL DESCRIPTIONS

Introduction

This section of the manual contains a functional description of the electrical circuits contained on the more complex PC boards and front panel assembly of the Model 8501A/8502A Peak Power Meters (PPM). Table 5-A lists all of the various circuit assemblies by reference designation, and includes the Schematic Diagram (SD) and assembly number for each board.

There is one electrical characteristic that is common to all of the PC boards in the PPM. This is the method used to provide the proper grounding configuration throughout the instrument. Each PC board contains both input and output isolator stages. This is to transfer the ground reference from the Reference or Ratio Common Ground used when signals are passing between the PC boards, to an on-board Common Ground. When any signals leave the boards, they pass through another isolator stage which transfers them back to the between-the-boards reference ground.

(This page is part of a fold-out sheet. Please fold this sheet out to the left and continue on page 5-4.)

Table 5-A. Model 8501A/8502A Circuit Assemblies

Ref. Desig.	Nomenclature	Ass'y. No.	SD No.
A1	Interconnect PC Board	16932	16933
A2	Power Supply PC Board	16995	16996
A3	GPIB/Cal Control PC Board	21014	21015
A4	C.P.U. PC Board	16878	16879
A5	Digital Delay PC Board	16685	16686
A6/A7	Analog PC Board	20741	20742
A8	Front Panel Interface PC Board	16911	16912
A9	Front Panel PC Board	16903	16904
A10	LCD Display PC Board	19620	16944
A11	Delay Line	16869	16944
A12	Calibrator	20055	17097
A13	Delay Line	16869	16944

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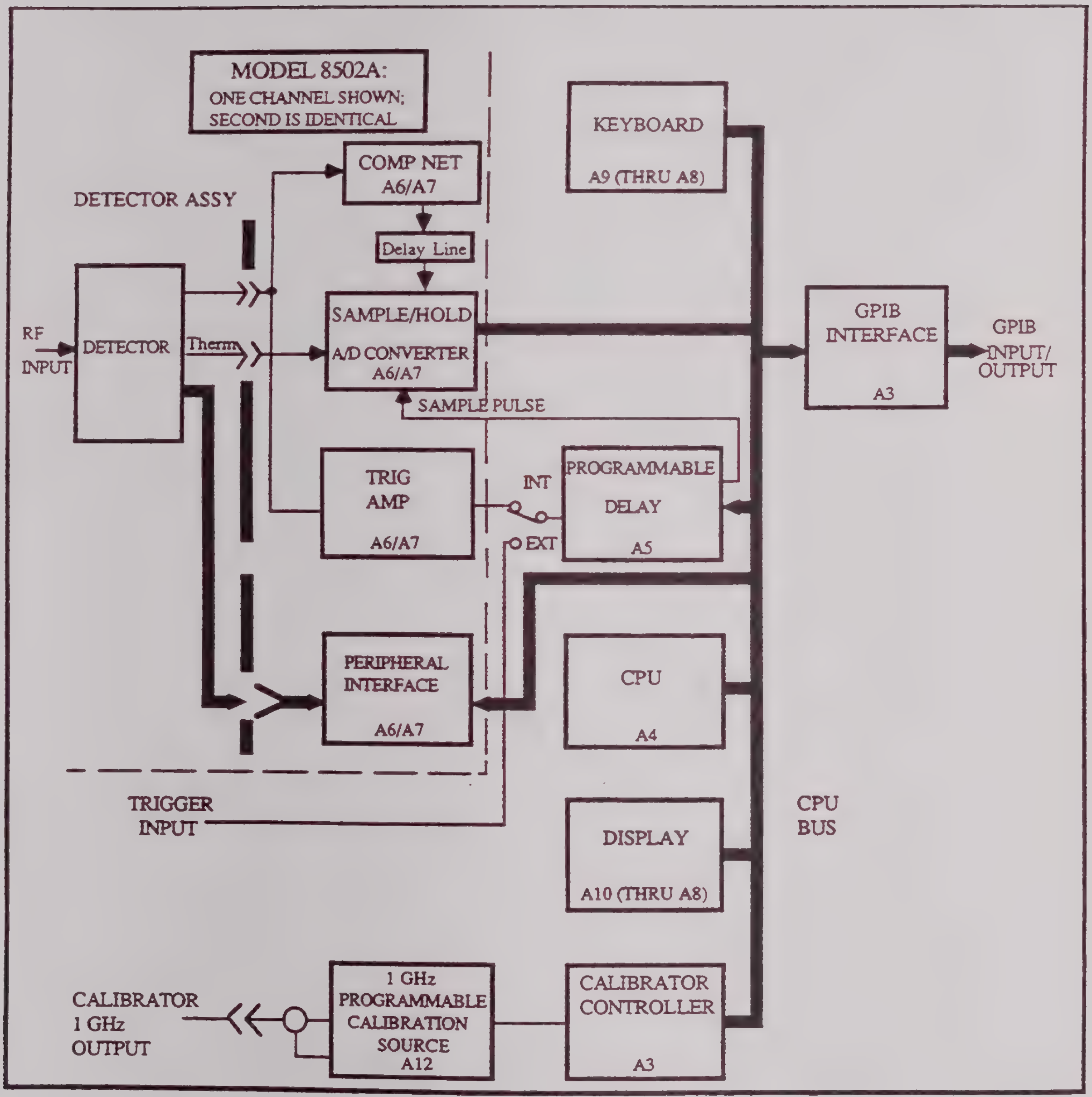
MODEL 8502A:
ONE CHANNEL SHOWN;
SECOND IS IDENTICAL
DETECTOR ASSY
COMP NET
A6/A7
Delay Line
SAMPLE/HOLD
A/D CONVERTER
A6/A7
RF
INPUT
DETECTOR
Therm
SAMPLE PULSE
TRIG
AMP
A6/A7
INT
EXT
PROGRAMMABLE
DELAY
A5
KEYBOARD
A9 (THRU A8)
GPIB
INTERFACE
A3
GPIB
INPUT/
OUTPUT
PERIPHERAL
INTERFACE
A6/A7
CPU
A4
TRIGGER
INPUT
CPU
BUS
DISPLAY
A10 (THRU A8)
CALIBRATOR
1 GHz
OUTPUT
1 GHz
PROGRAMMABLE
CALIBRATION
SOURCE
A12
CALIBRATOR
CONTROLLER
A3

Figure 5-1. Model 8501A/8502A PPM System Block Diagram

8501A/8502A PPM System Description

(See Figure 5-1 on page 5-3)

The detected RF signal enters the PPM as an analog voltage, and is received by the circuits of the Analog PC Board (A6/A7). (The single channel Model 8501A uses only A6 whereas the dual channel 8502A uses both A6 and A7. Both boards are identical.)

The Analog Board circuits first use an RC network to compensate the signal for frequency dependent losses in the delay line. Then the signal is sampled and held until the completion of the data conversion cycle. A/D conversion is done here to supply digital data to the CPU (Central Processing Unit).

The Trigger Amplifier of the Analog Board senses the detector output voltage before it reaches the Delay Line, and uses the signal to provide an Internal Trigger (controlled and conditioned by the Digital Delay Board - A5) when the internal trigger is selected.

The Peripheral Interface circuits are used to interface read or write signals (under the control of the CPU Board).

The Analog Board also receives temperature information sensed by the Thermistor inside the housing of each detector.

The Programmable Delay function of the Digital Delay Board (A5) is used to establish the time delays used when measuring RF pulses. Trigger inputs can come from either the CPU (internal), through the Trigger Amplifier from the pulse itself as it is detected, or from an external source connected to the rear panel of the instrument. The Delay Board also is used to supply a sync output signal to a rear panel connector which allows an external meter to be used to read the pulse at the point where the sample is taken.

The CPU Board (A4) provides, through the CPU Bus Line, the interface between the other PC boards, and generates all of the control signals required for timing and controlling the various functions of the boards. Apart from the bus, the CPU also has two other lines that come from the power supply and the delay board. These inputs tell the CPU if there has been a power failure of any kind, and when it should halt its activity until a sample of the incoming pulse is taken. This allows the sample to be unaffected by CPU generated interferance.

The Keyboard (A9) and Display (A10) PC Boards interface keystroke and Hand Wheel movement information, and display indication signals to and from the front panel components. These functions are controlled by the Front Panel Interface Board - A8 (in turn, controlled by the CPU). The front panel interface also has a high voltage switching power sup-ply for the Electro Luminescent (EL) display. The "Ready" and "New Data" lights on the front panel are turned on and off by control signals sent through A9 from the delay board.

The GPIB/Cal Control Board (A3) provides the interface to the GPIB, and contains the circuitry required for controlling the operation of the automatic detector Calibrator (A12). It also interfaces with the PROMs in the detectors, contains the sound generator circuits, and provides an RF blanking output to turn off RF power when zeroing the instrument.

The Calibrator Assembly (A12) contains the 1 GHz Programmable Calibration Source that furnishes a precise calibration signal for automatic calibration of the PPM's detectors.

Power Supply PC Board (#A2)

(See SD 16996 on page 8-13)

The Power Supply PC Board contains the circuitry for generating both the 5Vdc and 15Vdc power sources required by the instrument. Since both voltages are produced in a similar manner, this discussion will cover only the 5V circuitry.

The +5Vdc produced on the board is the master voltage regulator for the system. It takes its reference from CR21 and compares it with the output voltage between the +5V Sense and 5V Common lines. Sensing is done in the circuit composed of R41, R43, R66, and adjustable at R42. Q7 and Q5 are regulating transistors, with the regulation voltage available at TP9 for checking.

-5V is slaved from the +5V and regulated through Q9 and Q10. Both the plus and minus voltages are compared with ground, and both have current limiting. The +5V circuitry is sensitive to the voltage drop across R29 which is controlled in parallel through Q6. U2A is the current limiter for the +5V, and U3A is the current limiter for the -5V. U4 compares the unregulated +5V with the reference from U5. If its output is too low, the AC Fail signal will tell the CPU that the power is about to fail. R61, CR19, and C21 will keep the voltage supply at U4 up long enough for the +5V to drop to a logic zero threshold after the instrument goes to a power-OFF state.

Test Point Indications

TP1 Reads the current in the +15V drive circuitry

TP2 Reads the current in the -15V drive circuitry

TP3 +15V

TP4 15V Common Sense

TP5 -15V

TP6 15V Common

TP7 Reads the current in the +5V drive circuitry

TP8 Reads the current in the -5V drive circuitry

TP9 +5V Sense

TP10-5V Sense

TP115V Common Sense

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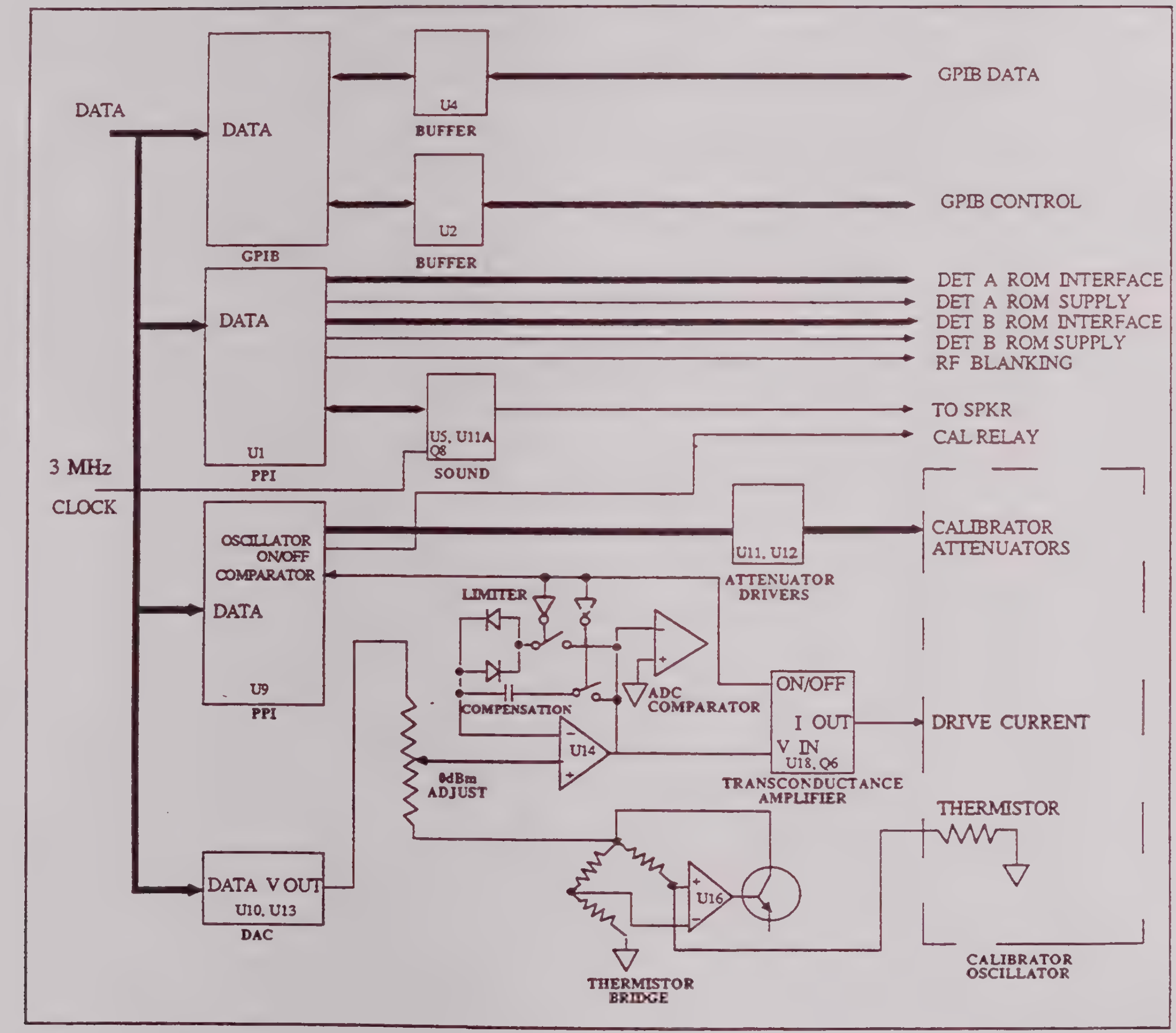
DATA
DATA
GPIB
U4
BUFFER
U2
BUFFER
GPIB DATA
GPIB CONTROL
DATA
U1
PPI
DET A ROM INTERFACE
DET A ROM SUPPLY
DET B ROM INTERFACE
DET B ROM SUPPLY
RF BLANKING
U5, U11A
Q8
SOUND
TO SPKR
CAL RELAY
3 MHz
CLOCK
OSCILLATOR
ON/OFF
COMPARATOR
DATA
U9
PPI
U11, U12
ATTENUATOR
DRIVERS
CALIBRATOR
ATTENUATORS
LIMITER
ADC
COMPARATOR
COMPENSATION
ON/OFF
I OUT
V IN
U18, Q6
TRANSCONDUCTANCE
AMPLIFIER
DRIVE CURRENT
U14
0dBm
ADJUST
THERMISTOR
DATA V OUT
U10, U13
DAC
U16
THERMISTOR
BRIDGE
CALIBRATOR
OSCILLATOR

Figure 5-2. GPIB/CAL Control PC Board Block Diagram

GPIB/CAL Control PC Board (#A3)

(See Figure 5-2 on page 5-7 and SD 21015 on page 8-17)

The GPIB/Cal Control PC Board circuitry performs a number of functions. The board is the interface to the detector PROM's, it contains the sound generator for making the various audible tones (as described in the Operation chapter on page 3-1), and it also has the GPIB interface and calibrator control circuitry.

Referring to Sheet 1 of SD 21015, the GPIB interface is through U1 (buffered by U2 and U4). U1 performs the proper interfacing between the GPIB and the Data and Address lines, and the chip select and read/write lines. Control signals to activate the sound generator come through U8, which also interfaces with the PROMs in each detector. A special 4-bit-wide data bus is connected to each detector, and a clock signal common to both detectors is used to sequentially count the address from zero to 2048.

Q1 and Q2 switch on and off the +5V supply to the channel A detector PROM, and Q3 and Q4 do the same for the channel B detector PROM. When the +5V is switched on, the address counter at the detector is reset to zero.

U8 also has an output called RF Blanking which is a signal used during a calibration routine to turn off any input from the RF source. The sound generator is controlled by U8 through U5. U5 drives an amplifier consisting of U11A and Q8, with the volume adjustable at R2. U7 is a frequency divider that takes a 3 MHz input and divides it by two so that the sound generator gets the 1.5 MHz input it needs for proper operation.

A major function performed by the GPIB/Cal Control board circuitry is to provide the control signals required to operate the automatic RF detector Calibrator. Prior to reading the following discussion, it is highly recommended that the Calibrator description on page 5-32 be read and the diagram of Figure 5-9 on page 5-31 be studied. This will provide a better understanding of the actual operation of the detector Calibrator, and help to clarify the interaction of the control signals generated by the Cal Control board circuitry.

Referring to SD 21015, Sheet 2, and Figure 5-2, PPI U9 is used to perform several functions. One function is the control of switches U12A, B,&C and U11B,C,&D. These switches are drivers for the pin diode switches in the Calibrator which switch in or out the required attenuation (as shown by the lines on the right side of the SD). Since the three sets of two switches each all operate the same, we will look at the action of U12A&B.

When a logic signal is generated from the B0 output of U9, the signal is applied to two inputs of opposite polarity (U112A, pin 6, is the minus input and U12B, pin 3, is the plus input). If the logic signal is high, this will force pin 7 of U12A to be driven negative and, conversely, pin 1 of U12B will be driven positive. This will turn on the pin diode switch in the Calibrator which will switch in the desired attenuation; in this case, the 10dB attenuator. If a logic zero comes from the B0 output of U9, then the reverse condition will be true and the attenuator will be switched out because current will be forced through the attenuator in the opposite direction.

PPI U9 also interfaces the U10 14-bit DAC with the incoming Data Bus lines. The interface consists of a byte wide data bus from U9 port A, two control lines from U9 ports C0 and C1 to U10 ports A0 and A1, and a write enable signal from U9 port C3 to U10 not-WR. The not-CS port on U10 is not used. Signals from A0 and A1 control the operation of U10 so that a write operation can either load the data into the DAC internal register's least significant byte or through DB0 to DB5 to the most significant byte or to transfer the register data to the DAC output.

U13 and U10 work together as a standard inverting operational amplifier. The loaded data connects the VREF input through a resistive network to an internal summing junction. The data is also connected to the feedback signal from the RFB input through an internal fixed value resistance, and to the inverting input of U13. Since VREF has a value of -10V, the output of U13 pin 6 will range from 0 to 10V.

Shown to the lower right of U10 on the SD is a summing junction which receives one signal from U13 through R15, and potentiometer R16 (CALIB SET) which is in parallel with R74. A second signal then comes from the thermistor bridge circuit of U16 and Q5. The bridge circuit uses the thermistor in the Calibrator as one leg of a bridge. The bridge is self-balancing, which means that it will always seek a voltage level that will keep it in balance. When the system is first turned on, the thermistor will have a high resistance because it is cold. This unbalanced condition will cause a maximum voltage level to be present at TP9. The voltage level will stay high until the thermistor warms up to a point where the bridge is balanced. Then the voltage level at TP9 will drop and, due to negative feedback, will seek a level which is just sufficient to maintain a balance in the bridge. The bridge voltage is fed back into the summing junction through R18.

The system has two modes of operation controlled by U17A&B which are, in turn, controlled by either a high or low output from the B7 connection of U9. In one mode, the circuit is used to measure the voltage of the bridge (initiated by a low output from B7); in the other mode of operation, the circuitry is used to control the bridge voltage (initiated by a high output from B7). When it is required to measure the bridge voltage, the Calibrator must be turned off so the voltage that selects the measuring mode also turns off the oscillator. The reason for this is that the ambient voltage of the bridge must be measured with no RF applied. U17B has two parts, one of which serves to invert the logic signal through pin 14 which is the inverse of what comes in through pin 16. The other half of U17B switches the signal into the oscillator control circuit which causes the oscillator to turn off. This is done when the switch is closed by causing the signal to unbalance the oscillator control circuit in such a way that no current can flow to the oscillator. Under that condition, C9 is disconnected from the circuit during the measuring period and the diode pair, CR1 and CR2, act to clamp the circuit to prevent U14's output from going more than 1V from ground independent of the applied signal. U15 is a comparator that detects whether the output of U14, pin 6, is either positive or negative. The output of U15 then goes to the C port of U9 as an input. This tells the CPU whether U14's output is either high or low as determined by the comparator. In the measurement mode, there is also a CPU driven successive approximation routine which puts a series of words out to the DAC, U10. Then, using standard successive approximation, the voltage level at TP9 is determined and placed in memory. On the basis of the voltage placed in memory and knowing the desired power out, the CPU can then calculate the voltage that must be written to U10 to control the oscillator for the desired output power. To briefly recap, the process is to measure the bridge voltage with no RF applied, determine the desired output power, and then write voltage corresponding to that power to the U10 DAC.

When it is required that the oscillator be controlled, the B7 output of U9 will supply a high voltage signal to close the switch at C9 and open the switch on CR1 and CR2. C9 then serves to stabilize the complete control loop while the thermistor bridge system controls the oscillator. The control system operates in the following way. The oscillator provides RF power to the thermistor and, the more RF applied, the less dc power is required in the self-balancing bridge. Consequently, as the RF power increases the voltage at TP9 will decrease. This voltage feeds into the summing junction at U14. Since diodes CR1 and CR2 are switched out of the loop, the feedback circuit then goes from pin 6 of U14 through R51 to the input of U18D. Pin 11 of U17B is open now, so there is no current fed to U18D from that point, and the voltage applied through R51 directly controls the current through Q6.

R47, R48, R49, R51, R52, U18D, and Q6 are used to form a voltage to current converter. The voltage over R49 will equal the input voltage present at R51, but will be shifted to be relative to -15V. (Can be read at TP7.) Referring to Figure 5-3, below, the current through R49 will be Vin/R49. Assuming that Q6 has a current gain much greater than 1, the current driving the oscillator can be approximated to Vin/R49. As the voltage increases, the oscillator output power and the RF power dissipated in the thermistor will increase resulting in a decrease of the bridge voltage at TP9.

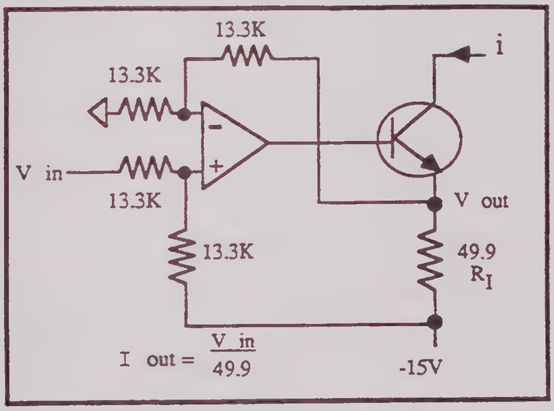

Figure 5-3. Voltage to Current Converter

Mathematically, the conversion function as shown in Figure 5-3 can be described as:

$$V+ = (Vin - 15)/2$$

$$V- = Vout/2$$

$$Vout = Vin - 15$$

$$i = (Vout + 15)R_1$$

$$i = Vin/R_1$$

The decrease of voltage will reflect as a decrease in the level of current and, finally, equilibrium will be obtained wherein there is just enough power being supplied to the oscillator to bring the summing junction to a balance at U14. The oscillator will then regulate at that level. The net result is that whatever is written into the U10 DAC will force the voltage at the thermistor bridge to the desired level to produce the required power level from the oscillator.

U18A is the buffer for the incoming +10V reference voltage. Q10 and Q11 are controlled by the B6 connection of U9 to provide a signal which can supply current to turn on a relay external to the PPM for special applications.

Test Point Indications

TP1	+5V
TP2	5V Common
TP3	-15V
TP4	15V Common
TP5	Output of the control amplifier for the Calibrator control. Its voltage (ranging from a few hundred mV to 10V) will be related to the power required by the Calibrator.
TP6	+15V
TP7	Measure from TP7 to TP3 to give an indication of the current through the oscillator. Will be between 1 and 30 mA.
TP8	+10V
TP9	Output of the thermistor bridge. Typically will have a voltage of about 7V under ambient conditions.

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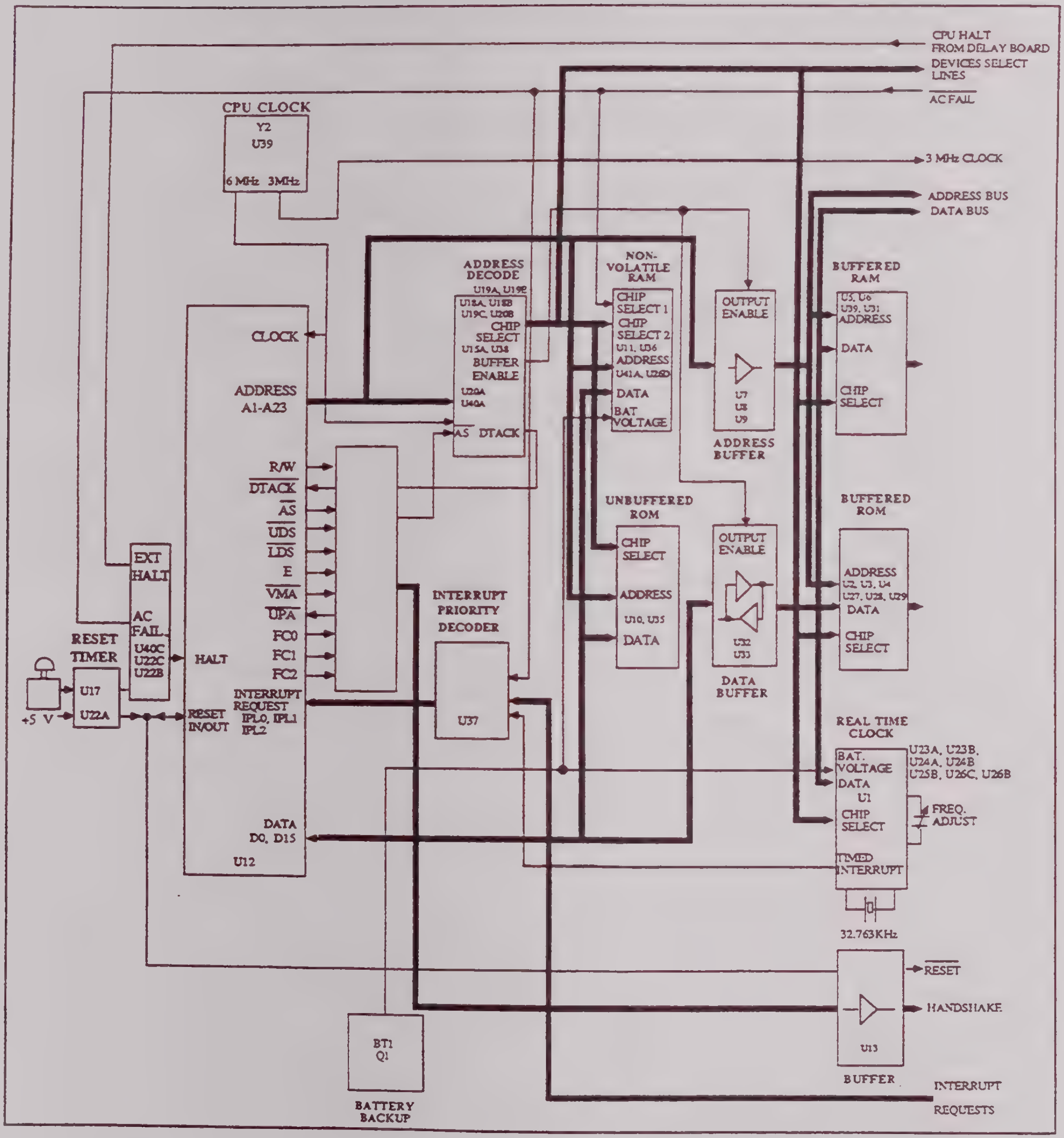
CPU HALT
FROM DELAY BOARD
DEVICES SELECT
LINES
AC FAIL
CPU CLOCK
Y2
U39
6 MHz
3MHz
3 MHz CLOCK
ADDRESS BUS
DATA BUS
ADDRESS
DECODE
U19A, U19E
U18A, U18B
U19C, U20B
CHIP
SELECT
U15A, U38
BUFFER
ENABLE
U20A
U40A
AS
DTACK
NON-
VOLATILE
RAM
CHIP
SELECT 1
CHIP
SELECT 2
U11, U36
ADDRESS
U41A, U26D
DATA
BAT
VOLTAGE
OUTPUT
ENABLE
U7
U8
U9
ADDRESS
BUFFER
BUFFERED
RAM
U5, U6
U39, U31
ADDRESS
DATA
CHIP
SELECT
CLOCK
ADDRESS
A1-A23
R/W
DTACK
AS
UDS
LDS
E
VMA
VPA
FC0
FC1
FC2
INTERRUPT
REQUEST
IPL0, IPL1
IPL2
HALT
RESET
IN/OUT
DATA
D0, D15
U12
EXT
HALT
AC
FAIL
U40C
U22C
U22B
RESET
TIMER
U17
U22A
+5 V
INTERRUPT
PRIORITY
DECODER
U37
UNBUFFERED
ROM
CHIP
SELECT
ADDRESS
U10, U35
DATA
OUTPUT
ENABLE
U32
U33
DATA
BUFFER
BUFFERED
ROM
ADDRESS
U2, U3, U4
U27, U28, U29
DATA
CHIP
SELECT
REAL TIME
CLOCK
U23A, U23B,
U24A, U24B
U25B, U26C, U26B
BAT.
VOLTAGE
DATA
U1
CHIP
SELECT
FREQ.
ADJUST
TIMED
INTERRUPT
32.763KHz
RESET
HANDSHAKE
U13
BUFFER
INTERRUPT
REQUESTS
BT1
Q1
BATTERY
BACKUP

Figure 5-4. CPU PC Board Block Diagram (Bd. #A4)

CPU PC Board (#A4)

(See Figure 5-4 on page 5-11 and SD 16879 on page 8-21)

The CPU (Central Processing Unit) PC board is used to control all of the various functions of the instrument. The circuitry of the CPU is logically divided between those circuits shown on Sheet 1 of SD 16879 and those shown on Sheet 2 of SD 16879.

Sheet 1 of SD 16879 shows the following CPU functions:

A. The Microprocessor (MPU).

B. Address decoding and handshake signal generating circuits.

C. Unbuffered memory.

D. Reset timer.

E. Interrupt Priority Decoder.

F. Data Buffers.

Sheet 2 of SD 16879 shows the following CPU functions:

G. External Memory.

H. Real Time Clock.

I. Backup Battery circuit.

Starting with Sheet 1 of SD 16879 and going in the same sequence as shown above, the functional operation of each CPU sub-circuit is described as follows:

A. THE MICROPROCESSOR.

The Microprocessor is a Motorola 68000 MPU. It has a 16 bit databus, 32 bit internal registers, and runs on a 6 MHz clock frequency. If it is desired to see the timing of the MPU in its various modes of operation, it is recommended that the user refer to the manufacturer's manual.

B. ADDRESS DECODING AND HANDSHAKE GENERATING CIRCUITS

This circuitry performs the address decoding for the memories and other devices included on the CPU board and elsewhere in the instrument. It generates the device select signals for the various components, creates the proper timing for each device, and performs the necessary handshaking for the transfer of data between the CPU and the different devices.

U18A&B, U20B, and U19C decode address lines 20 through 23 to select the multiplexer U34. The address strobe not-AS is active when the address lines hold a valid address.

(Note: The term "not-" preceding an address or signal line designation in this discussion indicates that the line is an active low. This is shown on the SD by a bar drawn over the line designation.)

Address lines 16, 17, 18, and 19 are used to select one of the 16 outputs of the multiplexer which will be used as the device select line (not-CS0 through not-CS15). Not-CS0 through not-CS7 are used to address the memories, not-CS8 through not-CS13 address different I/O devices, and not-CS14 and not-CS15 address devices that require a handshake according to the 6800 protocol.

U15A, U38, U19A,D&E, and U16 are used to create the proper timing and handshaking for each device category. When selecting one of the memories, U15A will produce a direct not-DTACK (Data Transfer ACKnowlege) signal to U12 through NAND gate U21C. The MPU will then execute the data transfer without introducing any additional wait states. When selecting one of the I/O devices (not-CS8 through not-CS13), the output of U38D goes high thus enabling the shift register, U16, which is clocked by the 6 MHz system clock. After three clock pulses, output QC goes high creating an active CE signal that is used by the Analog PC Board circuitry. After another clock pulse QD goes high, is inverted in U19A, and creates a delayed not-DTACK through U21C. The MPU responds by inserting a corresponding number of wait states in the data transfer which allows the device to time the data transfer. Not-DTACK can also be received from any external device connected to the CPU bus that has its own address decoding circuits.

When not-CS14 or not-CS15 are selected, U19E will generate a not-VPA (Valid Peripheral Address) signal through NAND gate U21B. This will tell the MPU that a valid 6800 device has been addressed, and the MPU will respond by generating a data transfer according to the 6800 protocol. The E and not-VMA (Valid Memory Address) outputs are used in this protocol. There is an external input to the not-VPA, and the not-VPA is also used in the interrupt process.

NAND gate U20A and inverter U40A are used to provide an active low signal when a device outside the buffers is addressed.

C. UNBUFFERED MEMORY

The memory inside the buffers consists of 2 8K*8 bits of RAM and 2 32K*8bits of ROM with the RAMs kept alive by a battery (non-volatile) when the instrument is turned off. NAND gate U26D (also battery powered) is deselected by the not-AC FAIL signal when the instrument is off to protect the contents of the memory. Each pair of memories use the 16 bit wide data bus and are addressed with one device select signal. The upper and lower data bytes are selected in OR gate U14 by letting the Upper Data Strobe (not-UDS) and Lower Data Strobe (not-LDS) gate the R/not-W output from the MPU to produce the Lower data Write Enable (not-L.WE), Upper data Write Enable (not-U.WE), Lower data Output Enable (not-L.OE), and Upper data Output Enable (not-U.OE) signals.

D. RESET TIMER

The reset timer, U17, consists of a 555 timer used as a monostable pulse generator. When the instrument is turned on or when the reset button on the back panel is pressed it generates a 0.5 second pulse which is used to reset the MPU. U22A&B give separate open collector inputs to the not-RESET and not-HALT inputs. U22C provides the not-HALT signal which comes from the Delay board. The not-RESET pin of the MPU is a bidirectional line, and the MPU can generate its own resets. Diode CR1 enables the not-AC Fail to Halt the MPU. This is necessary to ensure that the MPU is not trying to make a data transfer to the non-volatile RAMs or Real Time Clock when they are being deselected by the AC Fail signal.

E. INTERRUPT PRIORITY DECODER

The Interrupt Priority Decoder, U37, interfaces the three interrupt priority lines (IPL0, IPL1, and IPL2) to the seven interrupt request lines (IRQ1 through IRQ7). The three output lines of U37 will have encoded the number of the highest priority input line that has been driven low. As can be seen on the SD, the not-AC Fail line is connected to the highest priority interrupt input. The lowest priority interrupt input is connected to the Real Time Clock for timed interrupts.

F. DATA BUFFERS

Data buffers U7, U8, U9, U13, U32, and U33 are used to give an increased drive capability to all of the signals on the CPU bus that require the increased capability. They are all enabled by U40A from the Address Decoder circuit. This will happen each time none of the Unbuffered Memories have been selected. The R/not-W signal is used to determine the direction of data flow in the bidirectional buffers used with the data bus lines.

G. EXTERNAL MEMORY

The External Memory interfaces the buffered CPU bus. It consists of two pairs of 8K*8 bits of RAM (U5, U6, U30, and U31), and three pairs of 32K*8 bits of ROM (U2, U3, U4, U27, U28, and U29).

H. REAL TIME CLOCK

The Real Time Clock, U1, interfaces the Buffered CPU bus. Data transfer follows the 6800 compatible protocol with the E and not-VMA signals used to produce the handshaking required for the transfer. U23A&B, U24A&B, U25B and U26B are used to control U1. To see the timing used in the data transfer it is recommended that the manufacturer's data sheet for U1 (Motorola Type MC146818P) be consulted. C47 is used to adjust the frequency of the internal clock of U1. The 32.768kHz frequency can be monitored at TP6. The Real Time Clock also provides a timed Interrupt Request signal (IRQ1) that is used by the CPU operating system. Its frequency is software programmable, and can be monitored at TP7. The Real Time Clock is deselected by the not-AC Fail line through U26B.

I. BACKUP BATTERY CIRCUIT

The CPU board is supplied with backup power from the on-board battery, BT1, whenever the line voltage is off or too low to supply the instrument with the required input voltage. Transistor Q1 is turned on by the +15V supply to supply +5V to the circuits connected to the battery with a minimum drop in voltage. While the instrument is turned on, CR2 keeps the battery from being back charged.

Test Point Indications

TP1	System Clock. 12MHz
TP2	Read/Write signal from U13
TP3	5V Common
TP4	+5V
TP5	Reset Signal from U17
TP6	Real Time Clock (U1) Output. Used for Calibration
TP7	Interrupt Request Signal from U1
TP8	Battery Voltage
TP9	15V Common
TP10	+15V

(This page is part of a fold-out sheet. Please fold this sheet out to the left, and continue on page 5-16.)

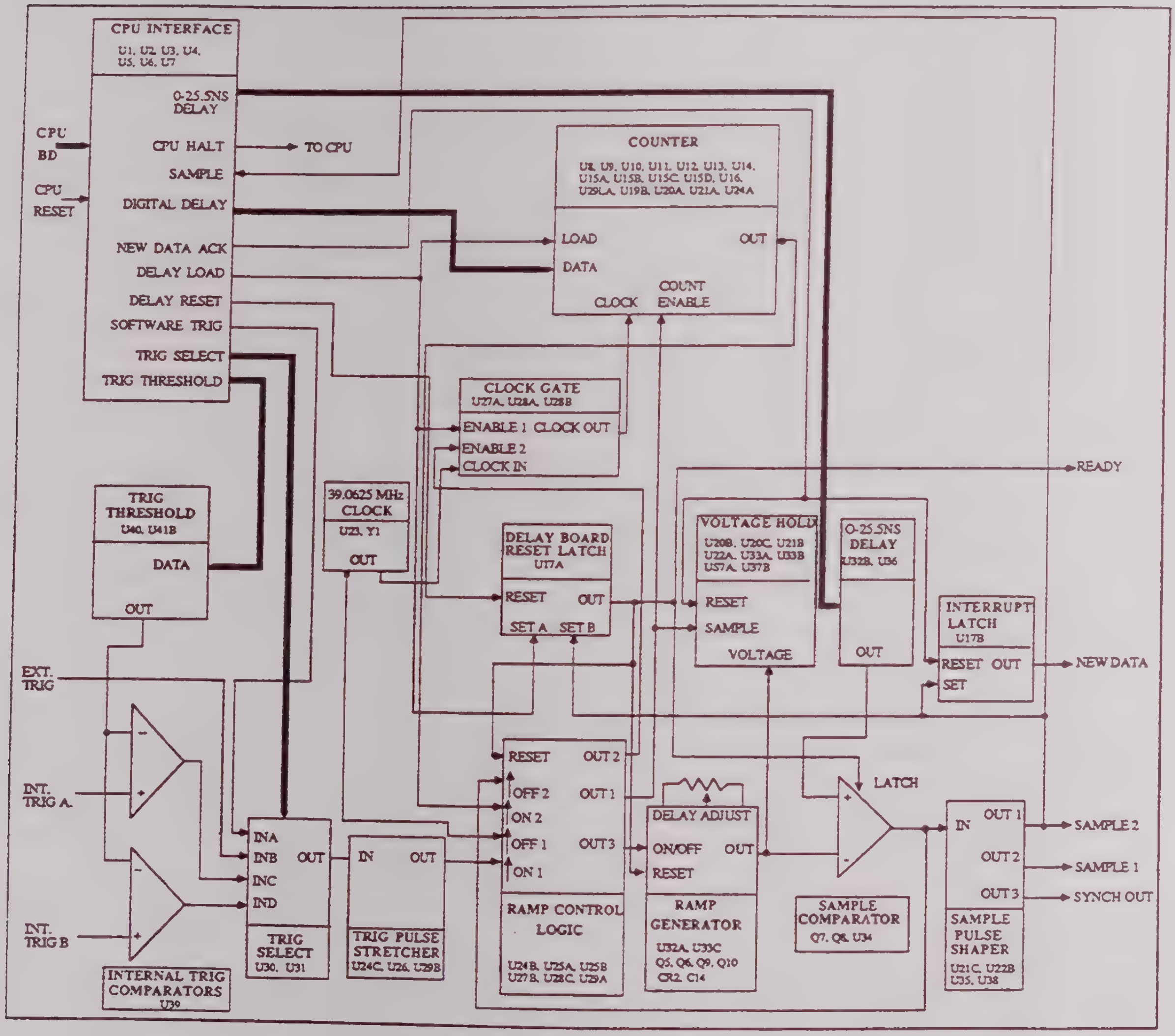
CPU INTERFACE
U1, U2, U3, U4,
U5, U6, U7
0-25.5NS
DELAY
CPU
BD
CPU HALT
TO CPU
SAMPLE
CPU
RESET
DIGITAL DELAY
NEW DATA ACK
DELAY LOAD
DELAY RESET
SOFTWARE TRIG
TRIG SELECT
TRIG THRESHOLD
COUNTER
U8, U9, U10, U11, U12, U13, U14,
U15A, U15B, U15C, U15D, U16,
U29LA, U19B, U20A, U21A, U24A
LOAD
OUT
DATA
COUNT
CLOCK
ENABLE
CLOCK GATE
U27A, U28A, U28B
ENABLE 1
CLOCK OUT
ENABLE 2
CLOCK IN
READY
TRIG
THRESHOLD
U40, U41B
DATA
OUT
39.0625 MHz
CLOCK
U23, Y1
OUT
DELAY BOARD
RESET LATCH
U17A
RESET
OUT
SET A
SET B
VOLTAGE HOLD
U20B, U20C, U21B
U22A, U33A, U33B
U57A, U37B
RESET
SAMPLE
VOLTAGE
0-25.5NS
DELAY
U32B, U36
OUT
INTERRUPT
LATCH
U17B
RESET
OUT
SET
NEW DATA
EXT.
TRIG
INT.
TRIG A
INT.
TRIG B
-
+
-
+
INTERNAL TRIG
COMPARATORS
U39
INA
INB
OUT
INC
IND
TRIG
SELECT
U30, U31
IN
OUT
TRIG PULSE
STRETCHER
U24C, U26, U29B
RESET
OUT 2
OFF 2
OUT 1
ON 2
OFF 1
OUT3
ON 1
RAMP CONTROL
LOGIC
U24B, U25A, U25B
U27B, U28C, U29A
DELAY ADJUST
ON/OFF
OUT
RESET
RAMP
GENERATOR
U32A, U33C
Q5, Q6, Q9, Q10
CR2, C14
LATCH
+
-
SAMPLE
COMPARATOR
Q7, Q8, U34
IN
OUT 1
OUT 2
OUT 3
SAMPLE 2
SAMPLE 1
SYNCH OUT
SAMPLE
PULSE
SHAPER
U21C, U22B
U35, U38

Figure 5-5. Digital Delay PC Board Block Diagram (Bd. #A5)

Digital Delay PC Board (#A5)

(See Figure 5-5 on page 5-15 and SD 16686 on page 8-25)

The Digital Delay PC Board circuitry is used to establish any time delays that may be desired when examining sample pulses. Delays can be set in increments of 0.1 ns up to about 430 ms.

As can be seen in the block diagram, Figure 5-5, there is a highly complex interaction between each of the sub-functions of the delay board circuitry. For this reason, this discussion will be presented in three sections to give you a clearer understanding of this complex interaction. First, a brief description will be given for each of the blocks shown in Figure 5-5, then the overall functioning of the board will be described, and finally the sub-functions shown in each block will be described in detail.

A. CPU INTERFACE

The CPU Interface forms the link between the CPU bus and all of the sub-functions on the board that are controlled by the CPU. The Interface also controls the CPU Halt signal which is used to turn off all action by the CPU microprocessor from the time the delay board is triggered until a sample is taken. This serves to minimize the noise normally generated by the CPU when an analog signal sample is taken.

B. TRIG THRESHOLD

The Trig Threshold circuit sets the level for the Internal Trig Comparators. It accepts data from the Trig Level Bus, and produces a voltage between 0 and 2.5V which is sent to the comparators.

C. INTERNAL TRIG COMPARATORS

The Internal Trig Comparators consist of one fast comparator each for channel A and channel B's Internal Trigger Signals (only A is used in the Model 8501A). The comparators also contain overvoltage protection at each of the inputs to protect them against voltages higher than a maximum of 3.0V.

D. TRIG SELECT

The Trig Select is a digital multiplexer that selects either the Internal trigger from channel A or B, a software trigger generated by the CPU, or an external trigger from a source attached to the instrument's rear panel connection, all controlled through the CPU interface.

E. TRIG PULSE STRETCHER

The purpose of the Trig Pulse Stretcher is to make sure that the delay board is triggered only by the first leading edge of each trigger pulse. It stretches the pulse to 200 ns after the last trailing edge of the pulse. In this way, all glitches shorter than 200 ns will be removed from the pulse. Its input comes from the Trig Select circuit, and its output goes to the Ramp Control Logic.

F. CLOCK

The Clock is a crystal controlled, very stable, square wave generator. It operates at a frequency of 39.0625 MHz to give a 25.6 ns period.

G. CLOCK GATE

The Clock Gate provides the timing to the Counter when either in the count mode or in the delay data mode. When counting, the clock is enabled with a clock enable signal from the Ramp Control Logic and, when loading, it is enabled by a load signal from the CPU Interface.

H. COUNTER

The Counter is used to establish a coarse delay time. It is controlled by the Digital Delay Bus and the load signal from the CPU Interface. The clock gives it a resolution from 25.6 ns to a maximum delay of about 430 ms. The output is the selected clock pulse with just one gate delay with respect to the clock.

I. DELAY BOARD RESET LATCH

The Delay Board Reset Latch resets the board to accept the first trigger pulse after the reset is accomplished. The reset signal comes from the CPU through the Interface. The Latch resets the Ramp Control Logic, the Ramp Generator, the Voltage Hold, the Sample Comparator latch, and the Ready output that controls the "Ready" and "New Data" lamps on the front panel of the instrument.

J. RAMP GENERATOR

The Ramp Generator produces an accurate ramp that is used for the 0 to 25.6 ns delay. The Reset input presets the voltage at the output to a 3.0V bias. When turned on by the ON/OFF input, the voltage drops at a rate that can be adjusted with the Delay Adjust potentiometer. The output voltage can be held at a fixed value for a long period of time with the Voltage Hold circuit.

K. VOLTAGE HOLD

The purpose of the Voltage Hold circuit is to hold the output voltage of the Ramp Generator during the time it is waiting for the count output from the Counter. It consists of a double buffered sample and hold amplifier with input and output tied together. It is reset by the New Data Ack signal from the CPU Interface. The Sample input from the Ramp Control Logic samples the voltage for 33 µs and then holds the voltage. The hold mechanism only prevents the voltage from increasing, not from decreasing. A controlled current leakage ensures that the droop of the voltage is positive, and thus is taken care of by the Voltage Hold circuit.

L. SAMPLE COMPARATOR

The Sample Comparator compares the output from the Ramp Generator with the output voltage from the 0 to 25.6 ns Delay circuit. It has a latch input from the Delay Board Reset Latch. The latch prevents any change in the output of the comparator from the time the sample is triggered to the time the delay board is reset so that no spurious samples will be taken.

M. RAMP CONTROL LOGIC

The Ramp Control Logic controls the sequence of events that are required to generate the selected time delay. The Reset input enables the circuit to accept the first positive edge from the trigger pulse. The ON 1 input accepts the trigger pulse to turn on the Ramp Generator, enable the Counter, and to initiate the Voltage Hold. The OFF 1 input, consisting of the first negative edge of the clock signal after the trigger, turns off the Ramp Generator and enables the Clock Gate. The ON 2 signal comes from the Counter's count output and turns on the Ramp Generator. The OFF 2 signal consists of the Sample Comparator output which turns off the Ramp Generator when the sample is taken.

N. 0 to 25.5 ns DELAY

This circuit consists of a DAC controlled by the Delay DAC Bus through the CPU Interface circuitry. It sets the proper levels for a delay between 0 and 25.5 ns with an accuracy of 0.1 ns. Its output goes to the Sample Comparator.

O. PULSE SHAPER

The Pulse Shaper is triggered by the Sample Comparator and provides the sample signals to the samplers on the analog boards. It also provides a synch signal to the rear panel SYNCH OUTPUT connector of the instrument. The synch signal is simultaneous with the 15 ns wide Sample 1 signal. The Sample 2 signal is also used in the CPU Interface to end the halt signal to the CPU. Sample 2 also goes to the Interrupt Latch and the Delay Board Reset Latch to prevent any triggering from occuring until after the delay board has been reset.

P. INTERRUPT LATCH

The Interrupt Latch output goes directly to the CPU interrupt request input to alert the CPU that a sample has been taken. It is reset by the New Data Ack signal coming from the CPU Interface when the analog board has finished with the sampled voltage.

Delay Board Operation Description

(Reference Figure 5-5 on page 5-15, Figure 5-6 on page 5-19 and SD 16686 on page 8-25)

This section will describe the sequence of events that occur in the delay board starting with the reset of the circuits, and continuing through the generating of the pulse sample outputs.

The positive edge of the Delay Reset signal at U17A pin 11 will clock the Delay Reset Latch whose output will enable the Ramp Control Logic, the Ramp Generator, and the Sample Comparator. The reset input of the ramp control flip-flops (pin 13 of U29A and U29B) is released so that another trigger input can be accepted. The Ramp Generator switch, U33C, that is holding the output voltage at its initial value will open and the Sample Comparator latch, U34, will be released.

At the time the trigger pulse occurs, the Pulse Stretcher will ensure that only the first positive edge of the pulse will be able to trigger the Ramp Control Logic. The ON 1 input will clock flip-flop U29A and its output (monitored at TP1) will then activate the following events:

a) Turn on the Ramp Generator.

b) Trigger the Voltage Hold circuit to take a 3.3 microsecond duration sample of the Ramp Generator's output voltage and then to hold it.

c) Enable the Ramp Control Logic flip flop, U25B so that it can accept the Clock signal for the required timing.

d) Enable the U14 counter.

The first positive edge of the pulse from the Clock-inverted output at U23B pin 14 will time flip flop U25B to turn off the Ramp Generator and also to enable the Clock Gate. The Ramp Generator output voltage will then remain stable while the Voltage Hold function is taking a sample of it. The next clock pulse then starts the Counter counting down. When it has counted down to zero, it will cause an inverted clock pulse to be gated at its output, U24A pin 8, which will in turn clock flip flop U25A to turn on the Ramp Generator.

As the output voltage reaches the level determined by the selected delay, the Sample Comparator U34 will flip and trigger the Pulse Shaper to produce the output pulse. The output will also turn off the Ramp Generator by resetting U25A in the Ramp Control Logic circuit. The Sample 2 leading edge then sets the Delay Board Reset Latch and the Interrupt Latch, and resets the CPU Interface Halt signal. When the instrument is first powered on, the Delay Board Reset Latch is set by the Load signal because no Sample 2 signal is generated at that time.

Activation of the Delay Board Reset Latch will then cause the following events:

a) The Ramp Control Logic flip-flops, U25B and U25A, will be reset.

b) The Ramp Generator output voltage will be reset to [illegible].

c) A ready signal will be sent to the front panel "Ready" lamp.

After the CPU has processed the requested interrupt, it will send a Non-Clear Ack signal to reset the Interrupt Latch and the Voltage Hold circuits.

A very important function in the operation of the delay board is the ability to precisely set a delay using a very stable clock with a frequency lower than the resolution of the board, and still be able to accept trigger signals that are not in synch with the clock. As can be seen in Figure 5-5 on the Ramp Output Voltage timing line, the time A from the trigger to the negative clock edge plus the time B from the ramp on negative edge to the set threshold point is always the same. This is one clock period plus the fine delay set by the 0 to 25.5 ns Delay DAC plus eventual gate and other delays. These delays are independent of the exact timing between the trigger signal and the clock.

Detailed Block Descriptions

The circuitry on the delay board uses both TTL and ECL circuits. Where very high speed of operation and/or low propagation delay is required, ECL circuits are used. The logic voltage levels for the ECL circuits are -0.81V to -0.98V for a logic '1', and -1.64V to -1.85V for a logic '0'. When an input is connected to ground it has a logic '1', and when it is connected to -5.2V it has a logic '0'. (ECL circuits use the -5.2V supply.) Special translators are required to translate between ECL and TTL signal levels. A high or low ECL output is always in reference to its non-inverted output.

(continued on page 5-20)

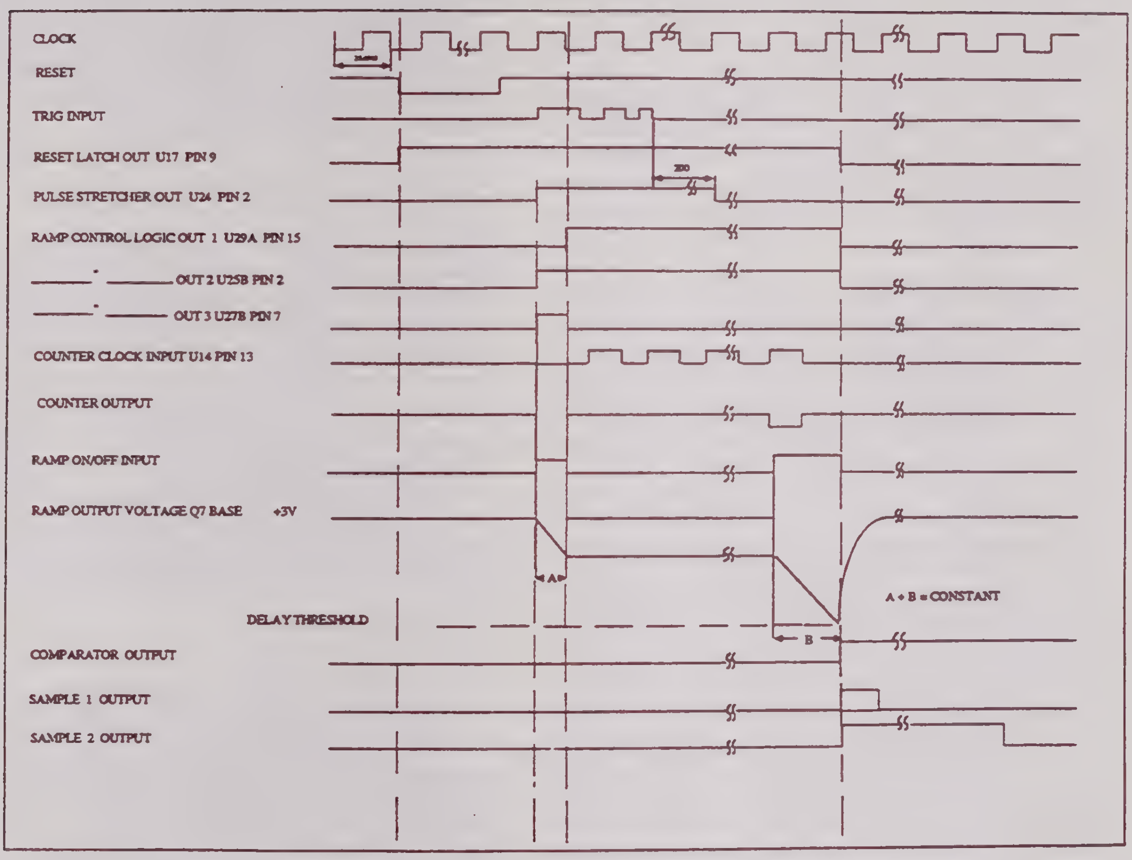
CLOCK
RESET
TRIG INPUT
RESET LATCH OUT U17 PIN 9
200
PULSE STRETCHER OUT U24 PIN 2
RAMP CONTROL LOGIC OUT 1 U29A PIN 15
OUT 2 U25B PIN 2
OUT 3 U27B PIN 7
COUNTER CLOCK INPUT U14 PIN 13
COUNTER OUTPUT
RAMP ON/OFF INPUT
RAMP OUTPUT VOLTAGE Q7 BASE +3V
A
A + B = CONSTANT
DELAY THRESHOLD
B
COMPARATOR OUTPUT
SAMPLE 1 OUTPUT
SAMPLE 2 OUTPUT

Figure 5-6. Timing Diagram - Delay Board Functions

A. CPU INTERFACE

All of the control of the delay board is accomplished through the two PPIs (Parallel Peripheral Interface), U6 and U7. They are configured so that all of their total of 48 ports are outputs. Both PPIs are selected through the CS10 line. Selection of U6 is done by having the write signal, WR, and the read signal, RD, gated by the lower data byte strobe, LDS, signal going to U4A. Selection of U7 is accomplished by the action of the upper data byte strobe, UDS, which goes to U4B. Address lines A1 and A2 are used to select one of the output ports, A, B, or C, or the PPI control register.

The delay is determined by the Delay DAC Bus from U6 port A, and by the Digital Delay Bus from U6 port B and U7 ports A and B. The delay can be set by one single long integer written to the board. The selected delay will be the inverted value of that integer. In other words, Delay = the maximum delay minus the set value. The trigger level is determined by the Trig Level Bus. It requires 10 bits of data which are sent from U6 port C and U7 ports C0 and C1. The trigger is selected by Trig Select 0 and Trig Select 1 from U7 ports C2 and C3. The delay board's interrupt acknowledgment, New Data Ack, comes from U7 port C7.

The Load, Reset, and CPU Halt signals are generated by U1, U2, and U3. If U2 multiplexes U7 ports C2 and C3 into the Y0 line, it tells the circuit to do nothing. Into the Y1 line means to reset, into the Y2 line tells it to load, and into the Y3 line indicates Halt Enable. To set the Halt signal, Halt Enable is used to set the latch U3A. Then, when Y1 is addressed, the following will happen:

1. The monostable pulse generator, U1, will generate a reset signal at the point where the negative edge of the signal at Y1 occurs.

2. After that, the positive edge of the signal at Y1 will clock U3B which will produce the Halt signal.

The Halt function will be reset by a signal through the Sample 2 line. If no sample has been triggered, it can be reset by the CPU Reset or the interrupt requests corresponding to data received from the keyboard or through the GPIB. This is done by resetting latches U3A and U3B. The Reset also activates the Software Trigger. This will be ignored by the delay circuits unless soft trigger has been selected.

B. TRIG THRESHOLD

The Trig Threshold circuitry consists of the 10 bit DAC, U40, amplifier U41B, and associated components. Its output is determined by the data present on the Trig Level Bus, and can be monitored at TP15. The amplitude range is 0 to 10.23V with 10 mV resolution. Registers R16 and R17 form a voltage divider to give a level between 0 and 2.56V which is sent to the Trig Comparators.

C. INTERNAL TRIG COMPARATORS

The Internal Trig Comparators function is accomplished by using one dual, fast ECL output comparator. Its recommended maximum input voltage is 3V. Each input is protected against overvoltage by an identical circuit. On channel A, the input is connected to the emitter of Q13. The base of Q13 is connected to 2.1V which is derived from the +15V supply through R8 and R9. When the voltage is greater than 2.1V plus the VBE(ON) of Q13, Q13 will then have a low resistance to ground that will serve to limit the comparator input voltage. The non-inverted outputs of the channel A and channel B comparators can be monitored at TP14 and TP15.

D. TRIG SELECT

The Trig Select circuitry consists of an ECL 4-wide 4-3-3-3 input, AND/OR gate U30, and a TTL-ECL translator, U31, for the trigger select lines. The trigger inputs are active lows, and are selected when the two remaining inputs of the OR gate are low. The output goes low when the selected trigger input goes low.

E. TRIG PULSE STRETCHER

The Pulse Stretcher function is initiated by the monostable multivibrator, U26, which is configured through its E+ and E- inputs by flip-flop U29B to accept only a negative sloping trigger, and by the 2-input OR gate U24C. All action takes place in the ECL format.

To better understand the operation of the Pulse Stretcher, assume to start with that the output of U29B has been clocked but not reset. The input would then be low. When the input goes high, the first thing that happens is that the output of the OR gate goes high. Then, the output of U29B will be reset causing the second input of the OR gate to go high. When the input goes low it will trigger U26 into generating a 200 ns output pulse. U26 can be retriggered so that if the input signal contains more pulses that are less than 200 ns apart, the output will stay low until 200 ns after the last negative edge. When the output of U26 goes back to the high condition (the reset input of U29A is then low), U29A is clocked and the inverted output goes low. Since this means that both inputs of U24C are low, the output of the Pulse Stretcher will now go low.

After the PPM is first turned on, it is necessary to give the Pulse Stretcher one trigger input pulse (generated by the soft trigger function) to initialize it.

F. CLOCK

The Clock consists of U23A,B&C, and Y1. U23A is used as a positive feedback amplifier with the Y1 crystal. U23C provides a dc bias to the input and U23B is an output buffer. The frequency is adjusted with C79. The clock frequency can be measured with a high impedance probe at TP5.

G. CLOCK GATE

The Clock Gate consists of AND gates U28A and U28B whose outputs are OR'd in U27C. The clock is connected to both U28A and U28B, and can be gated by either the load signal on U28A pin 4 or by the Ramp Control Logic Out 2 on U28B pin 7.

H. COUNTER

The Counter consists of high speed ECL binary counter U14, five TTL binary counters U8, U12, U11, U10, and U9 (with the first one being S-TTL), and the clock input. ECL delay data is translated from TTL by U13. It is clocked from the Clock circuitry. During the delay count, the multiplexer U16 selects the Terminal Count (TC connection) of U14 as the clock input to U8, and the Carry Out (CO connection) of U8 as the clock input to U12, U11, U10, and U9. U11, U10, and U9 operate in a look-ahead, carry mode. U19A, U20A, and U24A are using the U8 Terminal Count and the U8 and U9 Carry Out to select the first clock pulse after the counter has counted up to a full count.

When all of the counters are loaded, they have to be provided with one clock pulse while the Load input is low (Parallel Enable for U14) to execute the load. In U14, this is done by the Clock Gate circuit. For the other counters, the load signal will be executed by having the multiplexer U16 delay the negative edge of the signal and inverting the signal using U15A,B&C.

I. DELAY BOARD RESET LATCH

The Delay Board Reset Latch function is accomplished by flip-flop U17A. Inverter U15E and NAND gate U20D are used so that U17A can be reset by both the Sample 2 and Reset signals.

J. RAMP GENERATOR

The Ramp Generator is driven by a dc current sink consisting of U32A, Q9, and Q10. U32 compares the voltage at R32 with a voltage reference provided by CR2, R29, R30, and R31. The output of U32, boosted in darlington configuration, will regulate the current through R32 to I = Vref/R32. The current which forms the slope of the ramp is adjusted by R30 (DELAY ADJ). Q5 and Q6 are configured as a differential pair driven by the differential outputs of the ECL gate U27B. When the Ramp Generator is off, the current flows from ground. When it is on, it discharges C14 at a rate equal to dV/dT = I/C. The starting voltage is provided by the +10V reference through R44 and R45 when switch U33C is closed.

K. VOLTAGE HOLD

The Voltage Hold circuit consists of amplifiers U37-A&B, analog switches U33A&B, monostable vibrator U22A, and NAND gates U20B&C. The output of U37B sinks all leakage current injected to the Ramp Generator output voltage mode. R46 provides a controlled leakage to ensure that the leakage is positive. Diode CR1 ensures that U37B will not prevent the voltage from decreasing when the Ramp Generator is turned on. U37's output voltage can be monitored at TP9. U37A serves as a buffer amplifier. Its output can be sampled and held by analog switches U33A&B. Before the sample is taken, U33B is closed to keep the voltage at 3.0V. When the sample is triggered, U22A produces a 3.3 μs pulse closing U33A. The leading edge of the pulse will also set the flip-flop formed by U22B&C whose output will open U33B. During the sampling period, C9 will be charged and will then hold the voltage.

L. SAMPLE COMPARATOR

The Sample Comparator consists of ECL comparator U34, Q7, and Q8. Q7 and Q8 are used to increase the input impedance of the comparator, and to stabilize the input bias current. U34 has a latch input that will keep the output of the comparator from changing when driven ECL low. U34's output can be monitored at TP11.

M. RAMP CONTROL LOGIC

(Description covered under M. RAMP CONTROL LOGIC on page 5-17.) TP1 can be used as an oscilloscope trigger when testing the Delay Board.

N. 0 to 25.5 ns DELAY

The 0 to 25.5 ns Delay is set by the 8 bit DAC U35 and amplifier U32B. The output is biased by R37 from the +10V reference, and has a range of -0.5V to +0.994V full scale with 5.86 mV resolution. The output voltage can be measured at TP6.

O. PULSE SHAPER

The Pulse Shaper consists of an ECL monostable multivibrator, U38, which will provide a 15 ns pulse. U35 provides buffered differential outputs to the Sample 1 line and the Synch Out signal. U22 provides a 4.3 ms Sample 2 pulse.

P. INTERRUPT LATCH

The Interrupt Latch consists of a D-type flip-flop, U17B. It is clocked by the Sample 2 line to produce an interrupt request New Data signal to the CPU, and is reset through the New Data Acc. line

Test Point Indications

TP1	Output of U29A. Trigger signal that tells when the board has been triggered and reset. Can be used to trigger a scope when testing the board.
TP2	-5.2V
TP3	5V Common
TP4	+5V
TP5	Clock Frequency (C79 adjusts)
TP6	Output of U36, U37 DAC which determines the 0 to 25.5 ns threshold.
TP7	U34 comparator input
TP8	U34 comparator input
TP9	U37B hold amplifier output
TP10	10V Reference
TP11	U34 comparator output
TP12	5V Common
TP13	U39 comparator output (trigger signal)
TP14	U39 comparator output (trigger signal)
TP15	U40. Trigger level DAC
TP16	+15V
TP17	15V Common
TP18	-15V

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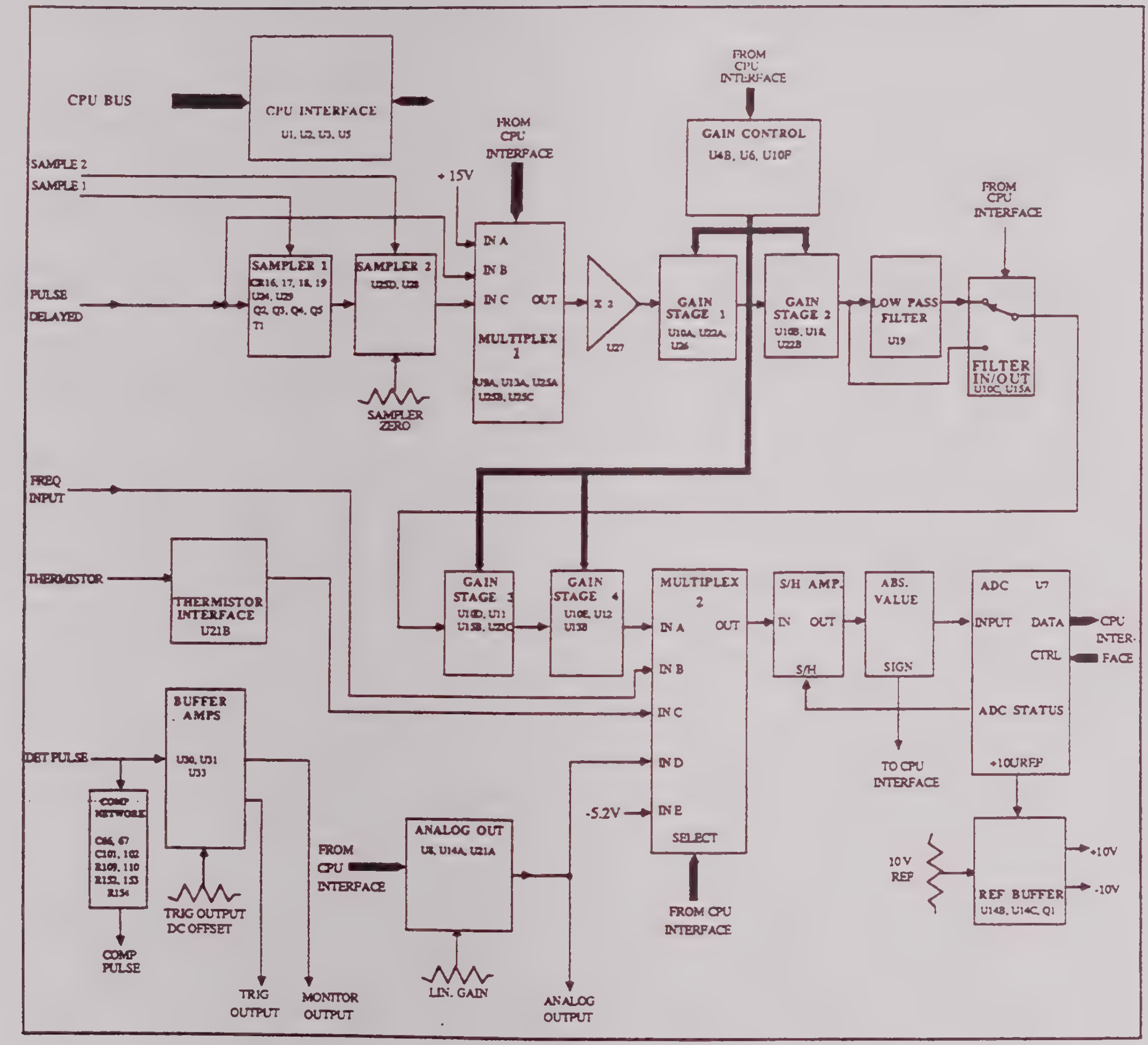
CPU BUS
CPU INTERFACE
U1, U2, U3, U5
SAMPLE 2
SAMPLE 1
PULSE
DELAYED
SAMPLER 1
CR16, 17, 18, 19
U24, U29
Q2, Q3, Q4, Q5
T1
SAMPLER 2
U25D, U28
SAMPLER
ZERO
FROM
CPU
INTERFACE
+ 15V
IN A
IN B
IN C
OUT
MULTIPLEX
1
U9A, U13A, U25A
U25B, U25C
X 2
U27
FROM
CPU
INTERFACE
GAIN CONTROL
U4B, U6, U10F
GAIN
STAGE 1
U10A, U22A,
U26
GAIN
STAGE 2
U10B, U18,
U22B
LOW PASS
FILTER
U19
FROM
CPU
INTERFACE
FILTER
IN/OUT
U10C, U15A
FREQ
INPUT
THERMISTOR
THERMISTOR
INTERFACE
U21B
GAIN
STAGE 3
U10D, U11
U15B, U23C
GAIN
STAGE 4
U10E, U12
U15B
MULTIPLEX
2
IN A
OUT
IN B
IN C
IN D
IN E
-5.2V
SELECT
FROM CPU
INTERFACE
S/H AMP.
IN
OUT
S/H
ABS.
VALUE
SIGN
TO CPU
INTERFACE
ADC
U7
INPUT
DATA
CTRL
ADC STATUS
+10UREF
CPU
INTER-
FACE
10 V
REF
REF BUFFER
U14B, U14C, Q1
+10V
-10V
BUFFER
AMPS
U30, U31
U33
DET PULSE
COMP
NETWORK
C66, 67
C101, 102
R109, 110
R152, 153
R154
COMP
PULSE
TRIG OUTPUT
DC OFFSET
TRIG
OUTPUT
MONITOR
OUTPUT
FROM
CPU
INTERFACE
ANALOG OUT
U8, U14A, U21A
LIN. GAIN
ANALOG
OUTPUT

Figure 5-7. Analog PC Board Block Diagram (Bd. #A6/A7)

Analog PC Board (#A6/A7)

(See Figure 5-7 on page 5-23 and SD 20742 on page 8-31)

The Analog PC Board circuitry is used to accept, convert to digital, and condition the analog voltage coming from the channel A and B RF detectors. A6 is the reference designation for the channel A board, and A7 is the designation for the channel B board. Both boards are configured exactly the same. The Model 8501A meter uses only A6.

Referring to Sheet 1 of SD 20742, the board first has an RC network that compensates for the frequency dependent losses in the delay, to assure correct pulse response. The signal is sent from the board to the delay line, and then returns to be applied to a fast sample and hold circuit (U29) with a sample pulse width of 15 ns. Next is a second sample and hold circuit (U28) with a pulse width of approximately 4 µs. The second sample and hold circuit is to ensure that the sampled signal that is present will not change in amplitude while it is being held. The signal is held during the time from when the sample is taken to the completion of the data conversion cycle. U28 can either use the sampled signal, or take the signal directly from the input without using the sampling circuitry.

There are four stages of gain available after the signal reaches U28. The gain can be either 1 or 8 through each stage. The circuits involved are composed of U27 with a fixed gain of 2, amplifier U26, U18, low pass filter U19, U11 which is the third gain stage, and U12 which is the amplifier for the fourth gain stage. All four stages are used only in the CW mode, and give a total gain of just over 8,000. In the peak pulse mode, the last amplifier (U12) is not used, so the total gain will be 1,000.

After the four gain stages, there is a multiplexer circuit that allows the selection of either the measured signal from the detector or the voltage from the thermistor in the detector. U21B will generate a voltage proportional to the thermistor temperature, and this voltage goes to U20 which generates a voltage proportional to the frequency.

U16, U17A,B&C, and U9 comprise a circuit that will give the absolute value and determine the polarity sign of the signal. U16 ensures that the voltage is steady during the conversion time. It receives the status (when conversion is occuring) from A to D convertor U7. The D to A conversion circuit formed by U8, U14A, and U21A is used to give an analog output proportional to the power level being sensed by the detector.

The system's 10V reference voltage comes from the U7 A to D convertor. U14C gives the +10V reference, and U14B gives the -10V reference. During the automatic self test routine of the instrument, the signal from the DAC (U8, U14, and U21) is tested to assure that these components are operating properly.

As an example of signal flow through the analog circuitry, when the first signal sample is directed to the fast sample and hold circuit, it comes in through the Sample 1 line (on the left side of the SD) as a balanced ECL signal, and then goes to differential receiver Q2 and Q3.

When a trigger is sent, Q2 produces a current pulse to trigger blocking oscillator Q4. The blocking oscillator generates a 20V pulse approximately 30 ns long at the secondary of T1. This pulse overcomes the reverse bias normally applied to the sampling bridge (CR16 - CR18), and drives a heavy current through it, thus connecting sampling capacitor C72 to the input signal during the sampling interval.

R120 is used to give a controlled discharge of C72 between the samples. This is done so that whenever a sample is to be taken, C72's voltage is close to zero to set it to the same condition for each of the samples. The reason for this is to assure repetitive accuracy for every sample of the specific signal being measured. U29 is a high impedance resolution amplifier, and R119 is a chosen value to give the best pulse response.

The second signal sample comes into the board through the line labeled Sample 2, and goes to a circuit which includes switch U25D, holding capacitor C70, and isolation amplifier U28. R136 serves the same purpose as R120 (to control C70's discharge). Setting the zero (or close to zero) dc offset level required while sampling is in progress is controlled at R112 (Sample Zero), and can be monitored at TP5.

Selecting between the CW or peak power mode signals is done through the U25A&B switches. U25-A&B can also select to look at the +15V signal through U13A. This allows the gain of the various stages to be separately checked using a known input. U27 has a fixed gain of 2. U25C (on the negative input of U27) is permanently closed, and is used to improve the common mode reaction of the amplifier to give identical characteristics to the plus and minus inputs.

Each of the four selectable gain stages are identical. They consist of, first, a comparator (U23) where the input signal is compared with a fixed level. Then, the signal from each of the stages is sent to the U6 latch. U6 can operate in several different modes. When measurements are being taken, the latch is in the autoranging mode. This means that the inputs for the latch are the signals from the comparators. The outputs, which directly follow the inputs in the autoranging mode, are controlling the switch and the gain circuits. The first gain stage, U22A, determines whether the gain will be 1 or 8 by selecting different feedbacks. If the routine is in a mode where several samples are being averaged, the first sample will be in the autorange mode and be amplified by the selected gain.

When autoranging is inactive (latch output is high impedance), the latch interfaces with outputs from the CPU to allow the CPU to control the gain. This mode is used during calibration or self test to allow the gain to be manually selectable.

U19 is a filter that can be selected to be either in or out of the gain loop. In the CW mode it is in the loop, but in the pulse mode it is not used to allow for a faster settling time during the analog to digital conversion. U19 is switched in or out of the loop by U15A.

U16 is an integrated sample and hold amplifier directly controlled by the status signal from the U7 A to D convertor. When U7 is given the command to convert, the status signal goes active and stays active until the conversion has completed. Then U17B, C, and D rectify the signal to give a positive output that is sent to one of the inputs of the U6 latch. Input 2D1 of U6 is used to determine the positive or negative status of the signal. U7 interfaces directly to the data bus, and has a built-in 10V voltage reference which is used throughout the system. R13 is used to adjust the value of the 10V reference.

The thermistor interface circuit, U21B, uses the resistance of the detector's thermistor in conjunction with the 10V reference to determine what the value of its output voltage (gain) will be. This output is then sent to the U20 multiplexer.

U8 is a 12 bit DAC. U21 gives a fixed offset so that there will be a resolution of exactly 2 mV corresponding to 0.02 dB when R47 is adjusted to the proper gain setting. The total range is from +30 to -50 dBm.

Sheet 2 of SD 20742 shows the buffer amplifiers used with the trigger signals and monitor outputs. The input to these amplifiers comes from the detector output voltage before it reaches the delay line (at the point where the detector cable interfaces with the instrument). PPI U1 has all of the output control signals and status inputs as well as an interface to the CPU bus.

The trigger amplifier consists of OpAmp U30, high speed buffer U31, analog switch U32, and peripheral circuitry. U30 and U31 form a composite amplifier with U31 transmitting the ac information through C106, and U30 transferring the dc information through R165. R113 adjusts the dc offset of U30. Analog switch U32 sets the gain of U30 either to unity or to 10. In the X10 gain range the rise time of the trigger signal is slower. The monitor output is taken from U33, and is not corrected for off-set.

U2A,B,C&D and U3A,B,C&D are the final address decoders. The chip select line, the Address line (A14), and data strobes are used to choose whether to activate the A to D or D to A convertor, or to activate PPI U1 which is controlled by the data bus and will interface read or write signals through the A1 and A2 lines.

Sheet 3 of SD 20742 shows the voltage input and grounding configurations for all of the IC's on the Analog PC board.

Test Point Indications

TP1	Reference Common
TP2	+10V Reference
TP3	Output of the analog DAC
TP4	Analog output as seen on the rear panel connection
TP5	Output of the 2nd sample and hold, U28
TP6	+5V
TP7	5V Common
TP8	-5V
TP9	+15V
TP10	-15V
TP11	15V Common

TP12	Can be used as scope trigger
TP13	0Vdc adjust readout point

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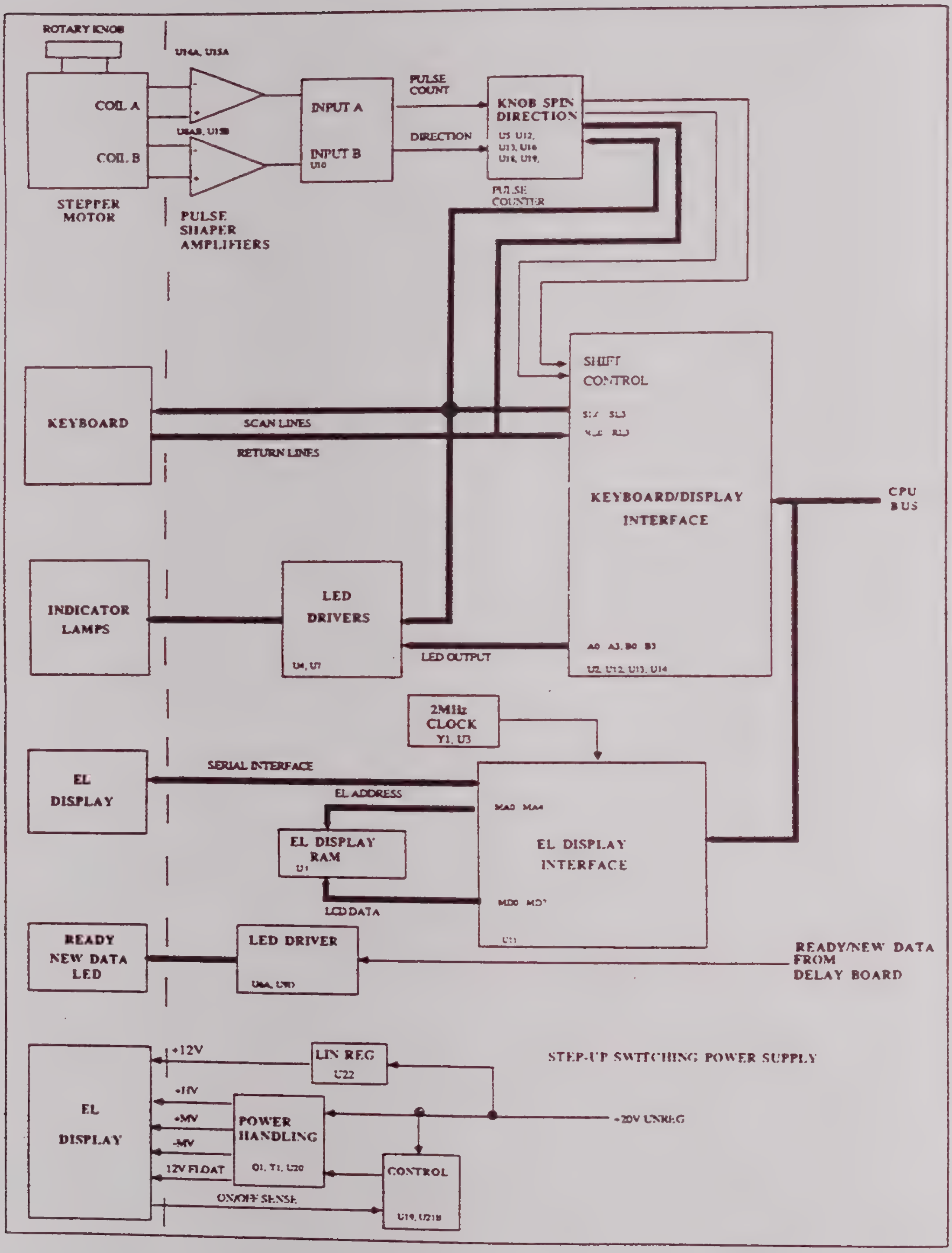
ROTARY KNOB
U14A, U15A
COIL A
U14B, U15B
COIL B
STEPPER MOTOR
PULSE SHAPER AMPLIFIERS
INPUT A
INPUT B
U10
PULSE COUNT
DIRECTION
KNOB SPIN DIRECTION
U5 U12, U13, U16 U18, U19,
PULSE COUNTER
SHIFT CONTROL
SL0 SL3
RL0 RL3
KEYBOARD
SCAN LINES
RETURN LINES
KEYBOARD/DISPLAY INTERFACE
CPU BUS
INDICATOR LAMPS
LED DRIVERS
U4, U7
LED OUTPUT
A0 A3, B0 B3
U2, U12, U13, U14
2MHz CLOCK
Y1, U3
EL DISPLAY
SERIAL INTERFACE
EL ADDRESS
MA0 MA4
EL DISPLAY RAM
U1
EL DISPLAY INTERFACE
MD0 MD7
LCD DATA
U11
READY NEW DATA LED
LED DRIVER
U6A, U9D
READY/NEW DATA FROM DELAY BOARD
EL DISPLAY
+12V
LIN REG
U22
STEP-UP SWITCHING POWER SUPPLY
+HV
+MV
-MV
12V FLOAT
POWER HANDLING
Q1, T1, U20
+20V UNREG
CONTROL
U19, U21B
ON/OFF SENSE

Figure 5-8. Front Panel Interface PC Board Block Diagram (Bd. #A8)

Front Panel Interface PC Board (#A8)

(See Figure 5-8 on page 5-27 and SD 20196 on page 8-33)

The Front Panel Interface PC board contains circuitry to control the EL display of the instrument (through U1, U2, U3, and U7), to power the EL display, to provide the interface to the keyboard and front panel indicator lamps (through U2, U4, and U7), and to interface with the spin knob on the front panel.

Referring to Sheet 1 of SD 20196, U11 interfaces with the CPU, the data bus, chip select lines, read/write lines, the A1 address line, and the clock input line. The output of U11 goes directly to the EL display. U1 is a 69K RAM used to store what is being shown on the display. This means that there is a separate data address and data bus between U11 and the U1 memory. U2 (the display and keyboard interface) has logic for the selection of the read and write functions. It has a number of scan lines (outputs) designated SL0, SL1, SL2, and SL3 that go to the keyboard. Connection is made between one of the lines and one of the return lines (RL) to tell the circuitry which key was pressed. The scan lines are also connected to the peripheral drive circuit so that, together with the output lines A0 through B3 (connected to U7), the control of which indicator lamp is to be turned on is accomplished.

Referring to Sheet 2 of SD 20196, the circuit receives its input from the stepper motor that interfaces with the spin knob on the front panel. The output is a signal that corresponds to 16 different keys in the keyboard interface circuitry. Each one is equal to a speed at which the stepper motor is being turned. Also, there are two other lines on the interface IC (U17B) that sense that the spin knob is in use and what direction it is being turned (U12B through RL0 through 7, and SL0 & 1). This signal is input to U14A&B.

The stepper motor creates two sinusoidal signals that are 90 out of phase with each other. The voltages of these signals are proportional to the speed of rotation of the spin knob. That is, the higher the frequency (speed of rotation), the higher the voltage. U14A&B are low pass filters with the cut-off frequency determined by the slowest speed the spin knob can be turned (a small fraction of a Hertz). As the frequency increases, the level builds until it reaches a constant amplitude. The amplitude is input to timers U8A&B and used so that if the input level is above 2/3 of the level of the supply voltage, then the output will be high. If the input goes below 1/3 of the supply voltage level, it will go to zero. The function is similar to a Schmitt trigger with levels of 1/3 and 2/3 of the supply voltage.

U8A&B output a train of square waves which are also 90 out of phase with each other. The square waves go through RC networks, and then give four inputs to U10. Each one of the inputs represents an up or down-going edge of one of the U8A&B square waves. The output is a pulse train of short pulses that indicate when the spin knob is being moved. U21A receives the pulse train, and U17A, B,C&D decode the direction of movement. If the knob is turned in one direction, U21B will have the same pulse train. When the knob is turned in the other direction, the pulse train will not be present.

Flip flop U18A is a gate controlled by the data input signal. From U12A the signal goes to monostable oscillator U17A so that when the knob is first turned an approximate 100 ms pulse is generated (read at TP6). While this pulse is high, the U16 4-bit counter counts the number of pulses from the spin knob. The more pulses that are counted, the faster the rotation of the knob. When the count reaches 15, a carry out is generated and U9B stops the counter from starting back at zero. Thus the maximum count of 15 is preserved, indicating the fastest spin knob rotation. When the U17A 100 ms timer ends, the U17B monostable outputs a SHIFT signal for approximately 20 ms. This tells the U2 keyboard decoder that the spin knob was moved. The four bit count from U16 is coded onto RL0 - RL7 by the U5 demultiplexer and part of PAL U10. PAL U10 gates the scan lines SL0 and SL1 with the highest order bit from U16 to control U5. If the count is 0 - 7, the three lower order bits from the counter are coded onto R0 - R7 by U5 when SL0 goes high. If the count is 8 - 15, the three lower order bits are coded out when SL1 goes high. The state of the CNTRL signal from flip-flop U18B indicates whether the spin knob was turning clockwise or counterclockwise.

Referring to sheet 3 of SD 20196, we see the circuitry which supplies power to the EL display. +12V is regulated down from the unregulated +20V by linear regulator U22. The higher voltages are stepped up from the +20V unreg by a switching flyback power supply. U19 is a current mode switching regulator IC which runs the supply. U19 controls the output voltages by varying the duty cycle of FET Q1, the power switch. The current through Q1 is limited by U19-3 which monitors the voltage across sense resistor R44. The rise time of the flyback voltage is controlled by a damping network composed of C60, R32, and R41. The frequency of U19's operation is fixed at about 100 kHz by timing components R37 and C53.

Test Point Indications

TP1	5V Common
TP2	Clock - 2 MHz
TP3	+5V
TP4	Shift Signal
TP5	I Sense
TP6	Timer (100 ms pulse from spin knob movement)
TP7	Flyback
TP8	-HV
TP9	+HV
TP10	+20V Unreg
TP11	+MV
TP12	A Gnd

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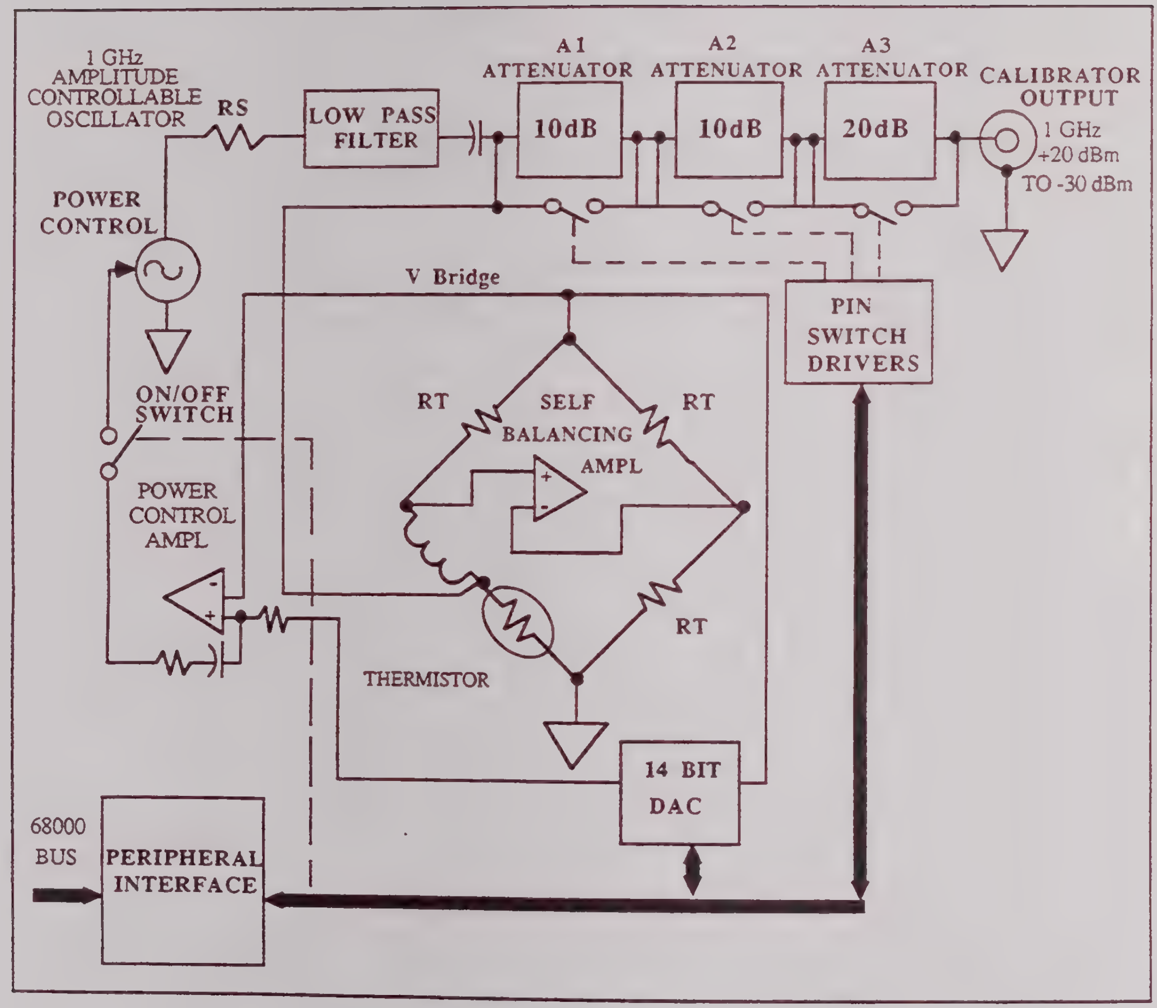
1 GHz AMPLITUDE CONTROLLABLE OSCILLATOR
RS
LOW PASS FILTER
A1 ATTENUATOR
10dB
A2 ATTENUATOR
10dB
A3 ATTENUATOR
20dB
CALIBRATOR OUTPUT
1 GHz
+20 dBm
TO -30 dBm
POWER CONTROL
V Bridge
PIN SWITCH DRIVERS
ON/OFF SWITCH
RT
SELF BALANCING AMPL
RT
POWER CONTROL AMPL
RT
THERMISTOR
14 BIT DAC
68000 BUS
PERIPHERAL INTERFACE

Figure 5-9. Automatic Detector Calibrator (Ass'y #A12) Functional Diagram

Calibrator (#A12)

(See Figure 5-9 on page 5-31 and SD 17097 on page 8-45)

The RF Diode Detector Automatic Calibrator uses a computer-controlled calibration circuit to generate precise calibration data using a simple power meter (thermistor) as a reference. This permits diode detectors to be used for absolute power measurements with the same accuracy usually associated with thermistor power meters.

Since the automatic calibration system is a completely new concept developed by Wavetek for calibrating diode detectors, the first portion of this discussion will be a general description of the overall theory involved in the system's operation. The last part of the discussion will cover the operation of the specific components contained in the calibrator assembly.

The system basically consists of an amplitude-controllable oscillator operating at a fixed frequency of 1 GHz. A portion of the RF output is coupled into a thermistor leveling circuit which is physically mounted inside the metal housing of the calibrator assembly. Referring to Figure 5-9, the thermistor is maintained at a fixed resistance by applying a dc bias current through it. This is achieved by using a self-balancing Wheatstone bridge with the thermistor inserted in one leg of the bridge. The amount of power required to maintain the thermistor at the fixed resistance, RT, is constant so that the RF power plus the dc power dissipated at the thermistor equals a constant. This constant can be determined by switching the RF power off and measuring the bridge voltage.

The oscillator output power can then be set by measuring this ambient bridge voltage and calculating the dc voltage which would balance the bridge when the oscillator has the required power output. When this required bridge voltage is written to the DAC on the GPIB/Cal Control PC board, the feedback causes the oscillator to settle to the selected RF power.

The above technique allows the calibrator output power to be precisely controlled over a dynamic range of approximately 15 dB. The dynamic range is increased by passing the oscillator power through a set of switched attenuators. The attenuators are designed to allow attenuation values of 0, 10, 20, 30, and 40 dB. The overall gain is adjusted so that the 20 dB stage will provide a precise 0 dBm reference with a specific power level out of the oscillator. Integrated control of the calibrator and detector permits errors in the other attenuator stages to be completely removed in the following manner.

With a particular attenuator switched in, the processor sets the oscillator output power to precisely 9 mW and measures the detector voltage. The next level of attenuation is switched in, and a successive approximation algorithm is used to find the oscillator power (about 90 mW) which will give precisely the same detector voltage. By dividing the two powers, the relative attenuation of the two ranges is obtained. Since the 20 dB range is adjusted to give a 0 dBm absolute reference, the absolute effective attenuation of each range can be calculated.

The automatic calibration system generates a table of detector voltages that are equivalent to known level of input power. This is done by applying many different input powers to the detector, measuring the amplified detector output, and storing the result. The calibration procedure is completely automatic, and the entire process including the range switching, attenuator measurements, and detector calibration takes less than one minute.

Since there is 15 dB of dynamic range in the thermistor leveled oscillator and 40 dB of attenuation available for insertion, the calibrator operates over a total 55 dBm dynamic range. Below -33 dBm, the diode detector itself is linear (square law), so the total dynamic range of the system will be 60 dB (-40 to +20 dBm).

The frequency response of each individual RF detector is measured over its entire specified range at the factory, and the information is stored in a ROM that is an integral part of the detector. Then, the frequency response information contained in the detector's ROM and the table generated by the calibration system are compared so that if a voltage equal to, say, -10 dBm is generated by the calibrator, the instrument looks at that voltage, compares it to its table, and by interpolating between data points knows that that specific voltage level equals -10 dBm. In this way, offset and gain errors in the detector amplifiers are removed and the system has the capability of measuring power over the full dynamic range of the detector with just as much accuracy as the power can be produced from the calibrator.

Refer now to SD 17097. Q1, together with the Base and Emitter Resonators, is the 1 GHz controllable oscillator. A portion of the signal from Q1 is coupled to a thermistor leveling circuit through the Low Pass Filter to remove harmonics, and through the wave Choke to allow connection to one end of the thermistor, RT1. The other end of the thermistor is connected to RF ground through an RF bypass line labeled FL5. RT1 samples the RF signal at the output of the low pass filter, and that sample is sent to the control circuitry on the GPIB/Cal Control PC board (see page 5-8 for description). The control circuit has a feedback system involving some amplifiers and associated circuitry as described in the GPIB/Cal Control Board discussion. The output from this feedback system controls the Q1 oscillator so that the voltage at the top end of RT1 is maintained at a constant level.

Following the thermistor leveling circuit is a series of pin diode attenuators comprising three stages of attenuation (10 dB, 10 dB, and 20 dB) for a total ca-pability of 40 dB. These stages are switched in and out by control signals from the GPIB/Cal Control board. In the first 10 dB stage, if the current through the attenuator is in the direction to turn on the series diode, CR2, then the attenuator is bypassed and minimum attenuation occurs. If the control current is in the other direction, CR2 is turned off and CR1 and CR4 will conduct so that 10 dB of signal will be lost. The other stages are similarly switched in and out to allow attenuation from 0 to 40 dB in 10 dB stages. The output then goes to the CAL connector.

R3 supplies current from the -10 to -13V control voltage source to the emitter of Q1, and R1 and R2 are bias resistors to provide a -10V bias to the base of Q1.

CHAPTER 6

PERFORMANCE VERIFICATION TESTS

Introduction

Information in this section is useful for periodic evaluation of the performance of the Model 8501A/ 8502A Peak Power Meters (PPM). These tests can also be used for receiving inspection testing when the instrument is first received, if required.

The Initial Instructions chapter of this manual should be reviewed to ensure that the instructions given therein have been complied with before the instrument is turned on. Prior to starting these procedures, the instrument should be allowed to warm up for at least 30 minutes to assure maximum stability during the testing.

Information given in this section can be used to calibrate and/or confirm calibration of the PPM and its detector(s) using the built-in automatic detector calibration system.

Equipment Required

(All test equipment must be within calibration specifications as given in the instruction manual or calibration procedures pertaining to each instrument or device.)

Description	Representative Model	Key Characteristic
CW Thermistor Power Meter	H. P. Model 432B	Inst. Acc. of at least 0.5%
Thermistor Mount	H. P. Model 8478B	1.1 SWR @ 1 GHz
Directional Coupler, 10 dB	Narda Model 3002, 10 dB	1.15 SWR @ 1 GHz
Attenuators, 10 to 50 dB in 10dB increments	Weinshel Model 1	1.15 SWR @ 1 GHz Accuracy < 0.1 dB
Precision Pulse Generator	Wavetek Model 178	10 ppm Freq. Accuracy
RF Source (Signal Generator)	Wavetek Model 2510A Option XP	> +20dBm @ 1 GHz & pulse mod
Low Pass Filter	H.P. Model 360B	30 dB Atten. @ 2 GHz
Return Loss Bridge	Wiltron 63N50 or 97NF50	Directivity 36 dB. Freq. Range from 1 GHz to max. freq. of sensor in use
Scalar Network Analyzer	Wavetek Model 8003	Freq. Range as above.
Digital Voltmeter (DVM)	Fluke Model 8600A	0.05% Accuracy
Precision DC Source	Digitec Model 3110	0.05% Accuracy
Graphics Plotter H.P.	Colorpro, Model 7440A	GPIB Compatible

The Performance Verification Checks given in this section are valid only if the detector has been automatically calibrated at an ambient temperature between +15°C and +30°C, and is operating within 5°C of the temperature at the time of calibration.

A Performance Verification Test Data recording sheet is located on page 6-7. This sheet should be removed, copied, and the copies used for recording test indications (as specified in the test procedure) each time a Performance Verification test is performed on this instrument.

Test Procedures

Initial Procedures

The tests in this section are done to determine that the performance of the Model 8501A or 8502A Peak Power Meter (PPM) is within the parameters of the specifications given for the instrument. Assemble all of the required test equipment and the PPM to be tested. Connect all equipment to the ac power line, turn it on, and allow at least 30 minutes for it to warm up before starting the test.

Calibrator Return Loss Test

Set up the 8003, 2510A, and the Return Loss Bridge to measure 0.95 to 1.05 GHz. Connect the bridge to the CALIBRATOR output on the front panel of the PPM. The return loss must be > 25 dB over the frequency range.

Calibrator Output Level Test

The following test will check the absolute level of the Calibrator function of the PPM. Note that verifying the level is not the same as setting the level. When the calibrator was previously adjusted, it was done using equipment capable of setting it to a level within the specifications of the instrument. The equipment used to verify the value also has its own uncertainties. Due to the nature of the measurement, equipment does not exist to make it practical to require a 10 times (or even 3 times) accuracy difference between the specified performance and the specified accuracy of the measuring equipment. Therefore, the uncertainty allowed for this test reflects both the uncertainty of the calibrator, and the uncertainty of the PPM and the detector used to verify it.

Place the PPM in the CW Mode by pressing the CW key, then press the MENU key and select Calibration. When the Calibration/Zeroing menu appears, press F1 and then immediately press the number key "7". Be sure that the Thermistor Power Meter is zeroed. Connect it to the CALIBRATOR output connection, and set it to the 1 mW range. The calibrator should read 1 mW. To be sure that the measurement is correct, the following steps must be performed exactly as given. ***Under no circumstances should any other key be pressed than the ones specified.***

CAUTION: Do not press any UNITS key when the Thermistor Sensor is connected to the Calibrator. This will cause the Calibrator to output 100 mW, and will possibly destroy the Thermistor Sensor.

1. Press CLEAR, then zero the Thermistor Power Meter.

2. Press number key "7", and read the Thermistor Power Meter. Take note of the meter reading.

3. Repeat Steps 1 and 2. Average six readings if successive readings are different.

4. Disconnect the Thermistor Power Meter from the CALIBRATOR connection.

The average reading in Step 3 should be 1.000 mW ±4.5% after correcting for the calibration factor of the thermistor mount at 1 GHz. Note that a smaller uncertainty than 4.5% can be supported by this technique if the calibration factor of the sensor has been determined by a primary standards laboratory such as the NIST (formerly NBS). This value merely reflects current commercial practice.

Power Linearity Test

Connect the test setup as shown in Figure 6-1. The linearity will be tested in a series of 10 dB steps over the range of the instrument. At low power levels, the linearity measurement will reflect the uncertainty due to the noise specification. Measurements will be made in both the CW and Peak Modes.

Refer to the CW Linearity Data and the Peak Linearity Data sections of the Performance Verification Data recording sheet on pages 6-7 and 6-8. These sections facilitate the collection of data for the CW and Peak power linearity test. The tolerance is already entered in each section for the various steps, and includes an allowance for specified noise errors at low power levels.

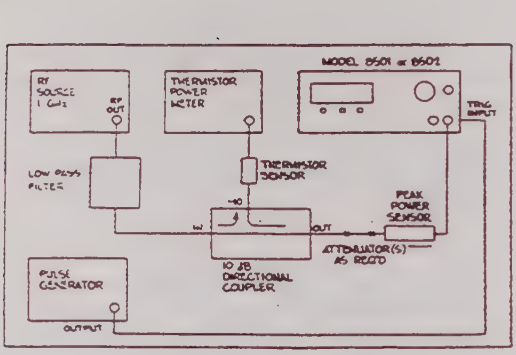

Figure 6-1. Power Linearity Test Setup

In order to make accurate measurements using the Thermistor Power Meter it is absolutely essential that it be zeroed properly. This should be checked frequently, keeping in mind that the instrument must be re-zeroed if any drift has occurred.

For each value of attenuation the following steps are to be performed:

1. After initial power-on and warm up, set the PPM to read CW power in mW, with the CW averaging number set to 500. This is done by pressing:

   CW→ MENU (2) → F1 → 500 → UNITS

   [MENU (2) means to press the MENU key two times to access Menu #2.]

   [UNITS means to press any Units (µs, ns, or ms) key on the right side of the numeric entry keypad.]

   Check that the display indication is in mW. If not, press MENU (4) → F3.

   Be sure that the RF source is set to 1.0 GHz.

   Then perform an automatic calibration on the detector (use channel A for an 8502A). Use this detector for the rest of the test.

   Automatic calibration is performed by, first, attaching the detector to the 1 GHz CALIBRATOR connection on the front panel of the PPM, and then pressing:

   MENU (1) → F3 → F1 → UNITS

2. Be sure that the Thermistor Power Meter is zeroed correctly. Adjust the RF Source for a reading of 10.0 mW ±0.25 mW.

3. Record the Power Meter Reading and the PPM Reading in the corresponding columns of the CW Linearity Data section on page 6-7 of the Performance Verification Test Data sheet.

4. Adjust the source to read 1.0 mW ±0.025 mW.

5. Record the Power Meter Reading and the PPM Reading in the corresponding columns on page 6-7.

6. Calculate the power ratio and reading ratio (using P1/P2 and R1/R2), and record these values in the indicated columns on page 6-7.

7. Calculate the linearity error using the formula:

   Linearity error (%) = ((R1/R2) / (P1/P2)-1)•100

8. Record this value in the "Linearity Error" column (above the "Accumulated Error" figure given for each attenuation level) on page 6-7. (Note that this value should be less than the value specified for "Accumulated Error" for each attenuation level.)

9. Add an additional 10 dB of attenuation between the coupler and the Peak Power Sensor, and repeat Steps 2 through 9. The next lower rows of the CW Data section of the Data Sheet will be used to record the readings taken for the 20, 30, 40, and 50 dB attenuations as Steps 2 through 9 are repeated for each level of attenuation. Add the previous and current linearity errors to determine the accumulated error.

10. Set the Pulse Generator to generate 5V pulses (TTL) with 10 microseconds duration and a repetition rate of 1 kHz. Connect the Pulse Generator output to the TRIG INPUT connection on the rear panel of the PPM.

11. Set the PPM to use an external trigger in the Peak Mode, mW display. Peak averaging is set to 100. This is done by pressing:

    PEAK → MENU (1) → F2 → MENU (2) → F2 → 100 → UNITS

    [If the display indication is not in mW, press MENU (4) → F3]

12. Remove all attenuators and repeat Steps 2 through 9 for the Peak Mode, recording the test indications in the Peak Linearity Data section on page 6-8 of the data recording sheet.

Delay Accuracy Test

If the Wavetek Model 178 synthesized Pulse Generator is not available, be sure that a Pulse Generator with at least 10 ppm frequency accuracy is used for this test.

Establish a known interval of time between two pulses, and verify that the PPM can measure it.

Set the Pulse Generator to generate a 10 µs wide pulse with a repetition rate of exactly 1.250 kHz. Adjust the amplitude to 5V. Connect the Pulse Generator to the RF Source (Signal Generator) as shown in Figure 6-2, below. Set the Source to generate a 50 µs pulse when triggered by the Pulse Generator. Adjust the amplitude of the Source to 0 dBm or greater. The frequency of the Source is not important. Any Source operating within the range of the PPM will be satisfactory, so long as it can be modulated with an external pulse signal and has a rise time less than about 30 ns.

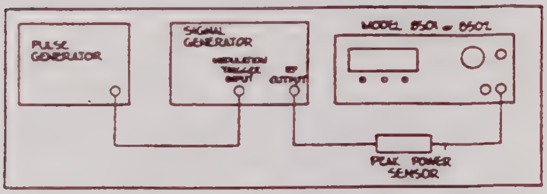

Figure 6-2. Delay Accuracy Test Setup

Set the PPM to read in the Graph Mode by pressing the GRAPH key. Press GRAPH to cause the autoscale function to be performed after the PPM has been connected to the Pulse Generator. A graph of the pulse profile should now be displayed. Then, proceed as follows:

1. Select a delay window of 0.2 µs, and set the cursor delay to place the cursor at the 50% point on the rising edge of the pulse.

2. Set the "Reference Delay" to be the value read at the 50% point of the first pulse (causing the cursor delay to be zero).

   a) Press DELAY (the menu prompt is displayed).

   b) Press DELAY (the Graph Mode is displayed).

   c) Enter the Cursor Delay Value.

   Now set the start delay to 799.90 µs. Set the cursor delay to place the cursor on the 50% point of the rising edge of the pulse. The cursor delay should read 800.00 µs ±0.08 µs.

Analog Output Accuracy Test

Set the RF Source to generate 0 dBm CW, and connect the channel A detector to the output (the only detector with the 8501A). Connect the DVM to the channel A analog output (the single analog output with the 8501A) on the rear of the PPM and, using the procedure given in the Power Linearity Test, Step 1 on page 6-2, set the PPM to read CW with an averaging factor of 900. Perform the following tests:

1. Adjust the RF Source so that the PPM reads exactly 0.00 dBm. Record the reading of the DVM. It should be less than 10 mV.

2. Adjust the RF Source so that the PPM reads exactly -10.00 dBm. Subtract the DVM reading recorded in Step 1 from the current reading. The magnitude of the difference should be 1.000V ±5 mV.

3. If a Model 8502A is in use, repeat Steps 1 and 2 after moving the DVM to the channel B analog output.

Voltage Proportional to Frequency Test

Press the MENU key three times (third menu) and select F3 to choose the source of frequency correction. Then press F2 to select the rear panel input. The input characteristics will then be specified as follows:

Voltage/GHz = 1.00
Sweeper Start Voltage = 0.000
Sweeper Start Frequency = 0.000

Adjust the Precision dc Source to 0.00V and connect it to the FREQUENCY input at the rear of the PPM. Select the CW Mode display. The FREQ readout at the bottom of the display should read 0.000 GHz. Set the Precision dc Source to exactly 10.00V. The display should now read 10.000 GHz ±0.050 GHz.

Detector Return Loss Test

Using the 8003 or another return loss test setup appropriate to the frequency range of the detectors to be used with the PPM, measure the return loss of the sensor(s) used with the PPM. Further information on the use of this type of equipment is available in Wavetek Microwave's Application Note AN20, "Swept Frequency Testing". Specifications depend on the type of sensor, its frequency range, and the type of connector being used. Refer to the specifications given on page 1-3 of the General Information chapter of this manual to determine the specifications for the particular sensor under test. When using this equipment, be sure to allow for the bridge directivity's contribution to measurement uncertainty (in dB); this must be subracted from the value of return loss specified for the detector.

Plotter Output/IEEE 488 Interface

Connect the signal generator to the PPM and display a pulse waveform in the Graph Mode. The pulse parameters, frequency, etc., are arbitrary for the purposes of testing the GPIB plot output of the PPM.

1. Using an IEEE 488 cable, connect the graphics plotter to the GPIB output connection on the rear of the PPM. Note the plotter address as selected on the plotter.

2. Press the MENU key six times, and select F2 to enter the plotter address. If the current address is different from the desired address, enter the correct address number.

3. Press the MENU key twice, and select F3 to begin the plot.

This completes the Performance Verification Tests of the PPM. If the instrument performed as given in this procedure, it is correctly calibrated and within published specifications.

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PERFORMANCE VERIFICATION TEST DATA SHEET

Date: ______________________________ Model 8501A or 8502A S/N: ________________
(cross out N/A above)

Operator: ______________________________

Test Number: ______________________________ (if required)

CW Linearity Data

						[1] Linearity Error (%)	
Total Atten.	Power Set Point	Power Meter Reading.	PPM Reading	Power Ratio	Reading Ratio	Linearity Specification	[2] Accumulated Linearity Error
0 dB	10.0 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.0 mW ±0.025 mW	P2 =	R2 =			±4%	*Same as Lin. error above*
10 dB	10.0 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.0 mW ±0.025 mW	P2 =	R2 =			±4%	
20 dB	10.0 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.0 mW ±0.025 mW	P2 =	R2 =			±4%	
30 dB	10.0 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.0 mW ±0.025 mW	P2 =	R2 =			±4%	
40 dB	10.0 mW ±0.25mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.0 mW ±0.025mW	P2 =	R2 =			±5%	
50 dB	10.0 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.0 mW ±0.025 mW	P2 =	R2 =			±14%	

---

[1] Linearity Error (%) = ((R1/R2) / (P1/P2) -1) • 100

[2] Accumulated error is the sum of the current dB segment linearity error plus the previous accumulated error.

Peak Linearity Data

Total Atten.	Power Set Point	Power Meter Reading.	PPM Reading	Power Ratio	Reading Ratio	[1] Linearity Error (%)	
						Linearity Specification	[2] Accumulated Linearity Error
0 dB	10.0 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.0 mW ±0.025 mW	P2 =	R2 =			±4%	*Same as Lin. error above*
10 dB	10.0 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.0 mW ±0.025 mW	P2 =	R2 =			±4%	
20 dB	10.0 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.0 mW ±0.025 mW	P2 =	R2 =			±7%	
30 dB	10.0 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.0 mW ±0.025 mW	P2 =	R2 =			±39%	

[1] Linearity Error (%) = ((R1/R2) / (P1/P2) -1) • 100

[2] Accumulated error is the sum of the current dB segment linearity error plus the previous accumulated error.

Other Test Results

(Listed in the same order as given in the text)

Section of Manual	Specification	Reading
Calibration Output Level, Step 3	0.955 to 1.045 mW	
Delay Accuracy, Step 2	799.92 to 800.08 µs	
Analog Output Accuracy, Step 2	0.995 to 1.005V	
V prop F Test	9.95 to 10.05 GHz	

CHAPTER 7

MAINTENANCE

Introduction

This section of the manual defines maintenance practices and troubleshooting procedures required for fault isolation down to PC board level.

It should be remembered that problems can occur that might be produced by equipment or components peripheral to the 8501A/8502A units. Preliminary checks should be made to be sure that a misadjustment or malfunction of external equipment or components are not causing what appears to be a problem within the instrument.

Periodic Maintenance

The following maintenance procedures should be performed once each year unless the meter is operated in an extremely dirty or chemically contaminated environment, or is subject to severe abuse (such as being dropped). In such cases, more frequent maintenance (immediate if the unit is dropped or severely abused in some way) is required.

A. Blow out all accumulated dust and dirt with forced air under moderate pressure. Also, ***the air filter for the cooling fan on the rear panel of the PPM should be checked every 3 months for accumulated dust.*** A dirty filter could restrict the air flow into the unit to the point where the instrument could overheat, causing the thermal sensor to shut the instrument off in the middle of a test routine. If dirty, the filter should be removed, cleaned with a mild detergent and water solution, and replaced. (If necessary, replacement filters can be ordered from the factory.)

   Removal of the filter from its holder is accomplished by snapping the retainer out of the holder. ***Do not remove the screws from the filter holder.***

B. Inspect the unit for any loose wires or damaged components. Check to see that the unit's PC boards are properly seated in their receptacles, and that all wire lead connectors are properly attached to their PC board pins.

C. The front panel and housing of the unit can be cleaned using a cloth dampened in a mild detergent. Do not use abrasive cleaners, scouring powders, or any harsh chemicals. Wipe the soap residue off with a clean, damp cloth, then dry with a clean dry cloth.

D. Make a performance verification check in accordance with the procedures found in Chapter 6 of this manual. If the performance is within the required specifications, no further service is necessary.

Calibration

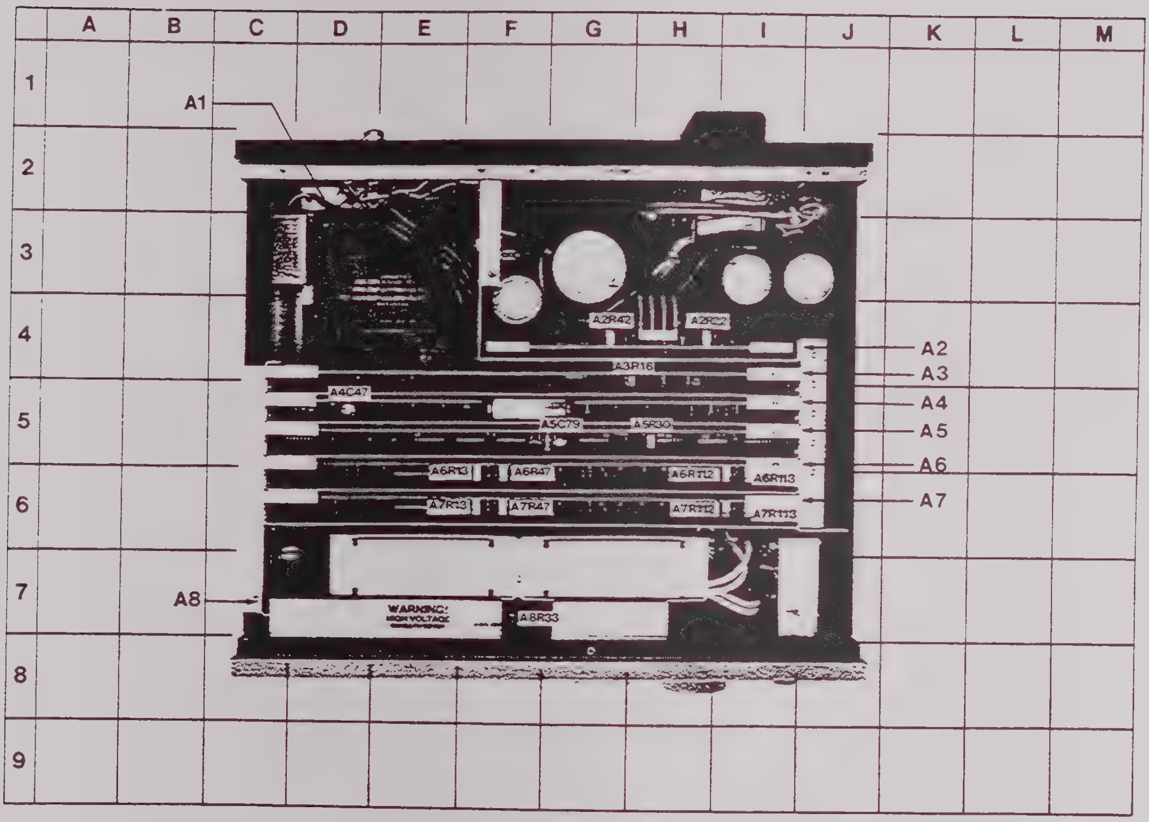
Using all solid state components, the Model 8501A/8502A meters are extremely rugged and reliable. Consequently, there is very little drift due to component aging, and adjustments to the units are rarely required. If measurements indicate that an adjustment is set within the indicated range, do not attempt to put it "right on". It is often the case that variations in the equipment being used to make the test account for small differences in measured values. Since some adjustments can be interactive, ***be absolutely sure that an adjustment is really required before making it.***

Except where specified, the instrument will be referred to as just "PPM" (Peak Power Meter) in these procedures.

Calibration Data Sheets covering the readings defined on pages 7-5 through 7-11 are included at the end of this section, starting on page 7-15. These sheets can be removed, copied, and the copies used for recording test and calibration data readings, if required.

NOTE: If it is desired to calibrate any of the RF detectors used with the PPM (such as after replacing the diode element), this can be accomplished in the field by using the Wavetek Microwave PROM Programming Accessory Kit, P/N 16976. This kit contains all of the necessary components and instructions required for proper detector calibration. If the kit is not available, the detector can be returned to the factory for calibration.

This page is part of a fold-out sheet. Please fold this sheet out to the left and continue on page 7-4.


A
B
C
D
E
F
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J
K
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M
1
2
3
4
5
6
7
8
9
A1
A2R42
A2R22
A3R16
A4C47
A5C79
A5R30
A6R13
A6R47
A6R112
A6R113
A7R13
A7R47
A7R112
A7R113
WARNING!
HIGH VOLTAGE
A8R33
A2
A3
A4
A5
A6
A7
A8

CKT REF	GRID LOC
A2R42	G-4
A2R22	H-4
A3R16	H-4
A4C47	D-5
A5C79	G-5
A5R30	H-5
A6R13	E-6
A6R112	H-6
A6R113	I-6
A6R47	F-6
A7R13	E-6
A7R112	H-6
A7R113	I-6
A7R47	F-6

Figure 7-1. Location of 8501A/8502A Calibration Components

Test Equipment Required

(All test equipment must be within calibration limits as specified in the instruction manual or calibration procedures pertaining to the particular piece of equipment.)

Description	Representative Model	Key Characteristics
Digital Voltmeter (DVM)	Fluke Model 8800	5 dig. dis., 0.01% accuracy.
Frequency Counter	EIP Model 548	10 digit readout. At least 1 GHz
Frequency Counter/Timer	Tektronix Model DC509	30 µs period 1 ppm
Oscilloscope (Scope)	Tektronix Model 465	5 mV/DIV and 50 MHz bandwidth
Power Meter	HP Model 432	0.95 to 05 GHz at 0dBm 1.3%
Precision Voltage Source	Digitec Model 3110	5.000V with 0.02% accuracy.
Pulsed RF Signal Generator	Wavetek Model 907	Trig. Modulator
Variac	General Radio Model W5MT3A	Metered
RF Detector	Wavetek P/N 16936	High Speed (15 ns)

PPM Preset Conditions

A. Set the Frequency Counter/Timer as follows:

1. Set FUNCTION switch to "PERIOD A".
2. Set AVERAGES switch to "10 to the 6th power".
3. Set SLOPE switch to "+".
4. Set ATTEN switch to "X1".
5. Set SOURCE switch to "EXT".
6. Set COUPL switch to "DC".
7. Set TRIG LEVEL switch to "AUTO".

B. Set the Signal Generator as follows:

1. Select MODE - PM (Pulse Modulation).
2. Select PULSE MODE - INT -PULSE.
3. Select RATE (HZ) - 1K.
4. Select PULSE DELAY - X1.
5. Select PULSE WIDTH - X1.
6. Adjust RATE to mid-way between 'MIN' and 'MAX'.
7. Adjust DELAY to approx. 3 µs (MINIMUM).
8. Adjust WIDTH to a point midway between 0.2 µs and 10 µs (approx. 5 µs).

C. Connect a cable from the SYNC NORMAL OUTPUT of the Signal Generator to the TRIG INPUT on the back of the PPM.

D. Connect the PPM to the Variac, set the Variac to 115VAC, and turn power on.

Procedures

(Figure 7-1 on page 7-3 is provided as a fold-out sheet that can be used as reference to locate the various components required for adjusting purposes during the calibration procedure.)

The procedures of the following sub-sections should be performed whenever the instrument is due for routine calibration, or when it is felt that calibration is required. All test points and adjusting components are labeled, and are accessible at the top of the PC boards. It is not necessary to remove any individual PC boards from the unit to perform these calibration procedures.

Regulator Board (A2)

A. +5 Volt adjust.

  1. Connect the DVM LO test lead to A2TP11.
  2. Connect the DVM HI test lead to A2TP9.
  3. Adjust A2R42 (+5V ADJ) for a DVM reading of +5.000V ±100 mV.
  4. Vary the Variac voltage from 100VAC to 130VAC.
  5. The DVM reading must not change more than ±5 mV.

B. -5.2V Check.

  1. Connect the DVM HI test lead to A2TP10.
  2. The DVM must read -5.200V ±200 mV.
  3. Vary the Variac voltage from 100VAC to 130VAC.
  4. The DVM reading must not change by more than ±5.2 mV.
  5. Set the Variac to 115VAC.

C. -15V Adjust.

  1. Connect the DVM LO test lead to A2TP6.
  2. Connect the DVM HI test lead to A2TP5.
  3. Adjust A2R22 (-15V ADJ) for a DVM reading of -15.000V ±15 mV.
  4. Vary the Variac voltage from 100VAC to 130VAC.
  5. The DVM reading must not change by more than ±15 mV.

D. +15V Check.

  1. Connect the DVM HI test lead to A2TP3.
  2. The DVM must read +15.000V ±45 mV.
  3. Vary the Variac voltage from 100VAC to 130VAC.
  4. The DVM reading must not change by more than ±15 mV.

E. Turn OFF the power.

F. Disconnect the Variac and plug the PPM into the bench ac mains connection.

NOTE 1: In all of the following instructions, the term "UNITS" included in any of the steps or commands means to press any Units key (µs, ns, or ms) located on the right side of the numeric entry keypad.

NOTE 2: The term "MENU" followed by a number in parenthesis means to press the MENU key the number of times indicated [e.g. MENU (6) means to press the MENU key six times].

Initialization

A. Turn the instrument on. The PPM will automatically a perform Self Test.

  1. At the completion of the Self Test, the PPM will return to the last setup before power down. If the Self Test failed, note the failure number and proceed by pressing CLEAR.

B. Calibrate the Detector.

  NOTE: The following portion of the Calibration procedure only needs to be done if the Detector being used is different than the one that was last used with the PPM.

  1. Press CLEAR.
  2. Connect the Detector (channel A detector if the unit is an 8502A) to the CALIBRATOR output.
  3. Press UNITS and wait for the calibration cycle to complete.
  4. Disconnect the Detector from the CALIBRATOR output.
  5. If the unit is an 8502A and a channel B detector is connected, perform the following steps.

a) Connect the channel B detector to the CALIBRATOR output.

b) Press CLEAR → UNITS and wait for the calibration cycle to complete.

c) Disconnect the detector from the CALIBRATOR output.

D. If needed or desired, the Internal Clock can be set as follows:

1. Press MENU (5) → F3 → F1
2. Enter the correct date (MMDDYY → UNITS
3. Enter the correct time (HHMMSS → UNITS → F3]

Front Panel Interface Board (A8)

A. EL Display Brightness Adjust

1. Connect DVM HI lead to A8TP9 (+HV).
2. Connect DVM LO lead to chassis.
3. Read the VWrite+ voltage shown on the sticker located on the back of A10 (the back of the EL Display).
4. Adjust A8R33 until the DVM reads within ±1V of VWrite+.

The display should be of even brightness across the screen without any smearing.

5. Disconnect the DVM leads.

Analog Board (A6/A7)

NOTE: Analog PC Board Nos. A6 and A7 are exactly the same. The Model 8501A uses just the A6 board whereas the Model 8502A uses both A6 and A7. When testing a Model 8502A, all A6 reference designations listed in this section will become A7 when the A7 board is tested.

A. +10V Reference Adjust.

1. Connect the DVM LO lead to A6TP1 (REF COMMON).
2. Connect the DVM HI lead to A6TP2 (+10V).
3. Adjust A6R13 (10V REF ADJ) for 10.000V ±3 mV.
4. If the unit is an 8502A, repeat Steps 1 through 4 for PC board A7.
5. Disconnect the DVM.

B. Sampler Zero Adjust.

1. Set the Peak Averaging Number to 20 by pressing MENU (2) → F2 → 20 → UNITS
2. Connect the sync output from the back of the PPM to the Ext Trig IN on the scope, the Scope HI lead to A6TP5, and the scope ground lead to A6TP11.
3. Set the pulse generator to generate a 10 µs wide pulse with repetition rate of 1 kHz and amplitude at 5V (TTL). Connect the pulse generator to the TRIG INPUT (TTL) on the rear panel of the PPM.
4. Press PEAK → MENU → F2
5. Adjust A6R112 (SAMPLER ZERO) for 0V ±2 mV offset at the end of the sample time.

C. Trigger Offset Adjust.

1. Set the trigger to channel A, Internal, -15 dBm by pressing:

   MENU (1) → F1 → (channel A if unit is an 8502A) → -15 → dBm

2. Connect the DVM HI lead to A6TP13 (TRIGGER OFFSET).
3. Adjust A6R113 (TRIG OUT DC OFFSET) for 0V ±1 mV offset.
4. If the unit is an 8502A, repeat Steps B and C for board A7.
5. Disconnect the DVM test leads.

D. Analog Output Adjust.

1. Press the RESET button on the back of the PPM.
2. Press MENU (11) → F1 → 1 → F2

NOTE: If the PPM required detector calibration

NOTE: If the PPM required detector calibration when the PPM prompts "CONNECT DETECTOR TO CALIBRATOR THEN PRESS ANY UNITS KEY", press "7" to access the service functions.

3. Connect a cable from the DVM to the ANALOG OUTPUT on the back of the PPM (ANALOG A output if the unit is an 8502).

4. Adjust A6R47 (LIN GAIN) for 0.000V ±10 mV reading on the DVM.

5. Press F3.

6. The DVM should read 3.000V ±25 mV.

7. Press F1.

8. The DVM should read -5.000 ±35 mV.

9. If the unit being tested is an 8502A, press F2 and repeat Steps 3 through 8 after moving the rear cable to the ANALOG B output.

E. Thermistor Sense Circuit.

1. Press CLEAR → 4 → F1

2. The reading should be approximately 5000 mV at a detector temperature of 30°C (82.4F). The reading will vary about ±0.2V/°C with any increase or decrease in temperature from the 30°C level. (A new reading is taken each time F1 is pressed.)

3. Press CLEAR → CLEAR

GPIB/CAL Control Board (A3)

CAUTION: The maximum output power of the Calibrator is over 100mW. Be sure it is working properly before connecting the Power Meter.

A. Calibrator Frequency Check.

1. Connect the Frequency Counter to the PPM CALIBRATOR output.

2. Select CALIBRATOR TEST MODE by pressing MENU → F3 → F1 → 7

3. The frequency must be 1 GHz ±50 MHz.

4. Disconnect the Frequency Counter from the CALIBRATOR output.

5. Press CLEAR.

B. Calibrator Output Adjust.

1. Zero the Power Meter.

2. Connect the Power Meter detector to the CALIBRATOR output on the PPM, and press key number 7.

3. Adjust A3R16 (CALIB SET) for 0 dBm.

   a) Press any numeric key. If the Power Meter indication is negative (e.g. -0.2 dBm), adjust A3 R16 in the CW direction to approximately twice the error.

   b) Press any of the numeric keys to take a reading.

   c) Repeat Steps a and b until the Power Meter reads 0.00 dBm.

4. Disconnect the Power Meter from the PPM.

5. Press CLEAR.

C. PPM Calibrate.

1. Connect the Detector (channel A if the unit is an 8502A) to the CALIBRATOR output.
2. Press UNITS.

3. Wait for the PPM to calibrate itself (about 1 minute).

4. Disconnect the Detector from the CALIBRATOR output.

5. If the unit is an 8502A, repeat Steps 1 through 4 for channel B.

CPU Board (A4)

A. Time Oscillator Adjust.

1. Connect the Frequency Counter/Timer common lead to A4TP3 (COMMON).

2. Connect the Frequency Counter/Timer test lead to A4TP6.

3. Adjust A4C47 for 30.517578 µsec ±0.000100 µsec.

4. Disconnect the Frequency Counter/

Timer test leads.

Digital Delay Board (A5)

A. Delay Oscillator Adjust.

1. Connect the Frequency Counter common lead to A5TP3 (5V Common).

2. Connect the Frequency Counter test lead to A5TP5.

3. Adjust A5C79 for 39.062500 MHz ±1 kHz.

4. Disconnect the Frequency Counter test lead.

B. Vernier Delay Adjust.

NOTE: This adjustment requires the use of the High Speed (15 nsec) Detector. **Do not attempt it with a Low Speed (750 nsec) detector.**

1. Connect the Detector (channel A if the unit is an 8502A) to the Signal Generator.

2. Place the PPM in the Graph Mode by pressing GRAPH

NOTE: The left half of the PPM display should look similar to Figure 7-2, below. The small vertical tics (division marks) at the bottom of the display represent 1/10th of the total display window. The left edge of the display is equal to the START DELAY, and the right edge is equal to the DELAY WINDOW plus the START DELAY. The small horizontal tics (division marks) going up the left side of the display represent the 10%, 50%, 90% and Reference Power (100%) levels.

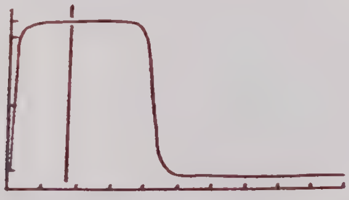


Figure 7-2. PPM Digital Delay Display

3. Select EXTERNAL TRIGGER by pressing MENU → F2

4. Adjust the Start Delay to move the start of the pulse near the beginning of the Graphics Display. This is done as follows:

   a) Move the Δ icon on the display (using the ↑ or ↓ keys) to the STRT DLY line.

   b) Rotate the Spin Knob CW until the start of the pulse is within 1/4 of a division of the start of the Graphics Display. Press UNITS

5. Adjust the Delay Window to 0.05 μsec by moving the Δ icon to DLY WIND, entering 0 .05 through the keypad, and then pressing μs

6. Set the Cursor Delay to the 25.6 nsec multiple (Table 7-A on the next page) that occurs after the start of the displayed pulse by moving the Δ icon to CRS DLY, entering the multiple value, and then pressing ns or μs.

7. Set the Start Delay to the value in the column to the right of the 26.5 nsec point in Table 7-A that was selected in Step 6 (above) by moving the Δ icon to STRT DLY, entering the number (e.g. 0.0196 which is 0.0256 minus 0.006), and then pressing μs

8. Set the Pulse Delay on the Signal Generator so that the rising edge of the pulse on the PPM display crosses through the cursor at approximately the input pulse's 50% point.

9. Set the Delay Window for 12 nsec by moving the Δ icon to DLY WIND, entering 12, and pressing ns

10. Set the Reference Power by moving the Δ icon to the REF PWR line and pressing UNITS.

11. Adjust A5R30 (VERNIER DELAY) to its maximum CCW position.

12. The display should look similar to Figure 7-3, below.

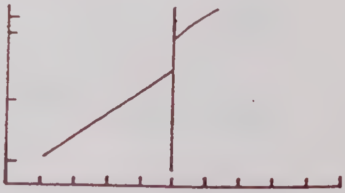


Figure 7-3. PPM Display w/A5R30 Max. CCW

(continued on page 7-10)

Table 7-A. Multiples of 25.6 nsec (Use with Digital Delay Board Cal, Step 6, on page 7-8)

Cursor Delay	Start Delay	Cursor Delay	Start Delay	Cursor Delay	Start Delay	Cursor Delay	Start Delay
25.60	19.60 ns	1.0240	1.0180 µs	2.0224	2.0164 µs	3.0208	3.0148 µs
51.20	45.20	1.0496	1.0436	2.0480	2.0420	3.0464	3.0404
76.80	70.80	1.0752	1.0692	2.0736	2.0676	3.0720	3.0660
102.40	96.40	1.1008	1.0948	2.0992	2.0932	3.0976	3.0916
128.00	122.00	1.1264	1.1204	2.1248	2.1188	3.1232	3.1172
153.60	147.60	1.1520	1.1460	2.1504	2.1444	3.1488	3.1428
179.20	173.20	1.1776	1.1716	2.1760	2.1700	3.1744	3.1684
204.80	198.80	1.2032	1.1972	2.2016	2.1956	3.2000	3.1940
230.40	224.40	1.2288	1.2228	2.2272	2.2212	3.2256	3.2196
256.00	250.00	1.2544	1.2484	2.2528	2.2468	3.2512	3.2452
281.60	275.60	1.2800	1.2740	2.2784	2.2724	3.2768	3.2708
307.20	301.20	1.3056	1.2996	2.3040	2.2980	3.3024	3.2964
332.80	326.80	1.3312	1.3252	2.3296	2.3236	3.3280	3.3220
358.40	352.40	1.3568	1.3508	2.3552	2.3492	3.3536	3.3476
384.00	378.00	1.3824	1.3764	2.3808	2.3748	3.3792	3.3732
409.60	403.60	1.4080	1.4020	2.4064	2.4004	3.4048	3.3988
435.20	429.20	1.4336	1.4276	2.4320	2.4260	3.4304	3.4244
460.80	454.80	1.4592	1.4532	2.4576	2.4516	3.4560	3.4500
486.40	480.40	1.4848	1.4788	2.4832	2.4772	3.4816	3.4756
512.00	506.00	1.5104	1.5044	2.5088	2.5028	3.5072	3.5012
537.60	531.60	1.5360	1.5300	2.5344	2.5284	3.5328	3.5268
563.20	557.20	1.5616	1.5556	2.5600	2.5540	3.5584	3.5524
588.80	582.80	1.5872	1.5812	2.5856	2.5796	3.5840	3.5780
614.40	608.40	1.6128	1.6068	2.6112	2.6052	3.6096	3.6036
640.00	634.00	1.6384	1.6324	2.6368	2.6308	3.6352	3.6292
665.60	659.60	1.6640	1.6580	2.6624	2.6564	3.6608	3.6548
691.20	685.20	1.6896	1.6836	2.6880	2.6820	3.6864	3.6804
716.80	710.80	1.7152	1.7092	2.7136	2.7076	3.7120	3.7060
742.40	736.40	1.7408	1.7348	2.7392	2.7332	3.7376	3.7316
768.00	762.00	1.7664	1.7604	2.7648	2.7588	3.7632	3.7572
793.60	787.60	1.7920	1.7860	2.7904	2.7844	3.7888	3.7828
819.20	813.20	1.8176	1.8116	2.8160	2.8100	3.8144	3.8084
844.80	838.80	1.8432	1.8372	2.8416	2.8356	3.8400	3.8340
870.40	864.40	1.8688	1.8628	2.8672	2.8612	3.8656	3.8596
896.00	890.00	1.8944	1.8884	2.8928	2.8868	3.8912	3.8852
921.60	915.60	1.9200	1.9140	2.9184	2.9124	3.9168	3.9108
947.20	941.20	1.9456	1.9396	2.9440	2.9380	3.9424	3.9364
972.80	966.80	1.9712	1.9652	2.9696	2.9636	3.9680	3.9620
998.40	992.40	1.9968	1.9908	2.9952	2.9892	3.9936	3.9876

13. Adjust A5R30 CW until the risetime of the displayed pulse is smooth (see Figure 7-4 below).

14. Set the PEAK AVERAGING NUMBER to 50 by pressing MENU (2) → F2 → 50 → UNITS

15. The rising slope of the pulse must still look smooth. If not, readjust A5R30.

16. Press GRAPH.

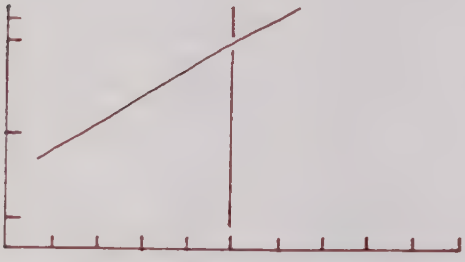


Figure 7-4. PPM Display w/Smooth Risetime

External Interface

A. Monitor Outputs.

1. Connect a terminated coaxial cable from the MONITOR output on the back of the PPM (channel A if the unit is an 8502A) to the Scope.

2. The Scope display should look like the pulse displayed on the PPM Graphics display with the amplitude representing the buffered detector signal.

3. If the unit being tested is an 8502A:

    a) Disconnect the channel A detector from the Signal Generator.

    b) Connect the channel B detector to the Signal Generator.

    c) Select B channel AUTOSCALE by pressing B → GRAPH

    d) Move the coaxial cable from the A channel MONITOR output to the B channel MONITOR output on the 8502A.

    e) The Scope display should be the same as Step 2.

4. Disconnect the terminated coaxial cable from both the 8502A and the Scope.

B. Sync Output.

1. Connect a coaxial cable (no termination) from the SYNC output on the back of the PPM to the Scope.

2. The Scope display should look similar to Figure 7-5, below.

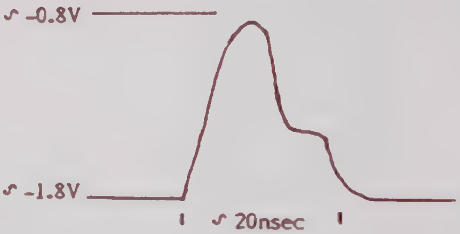


Figure 7-5. PPM Sync Output Scope Display

3. Disconnect the coaxial cable from both the PPM and the Scope.

C. Frequency Input.

1. Connect a coaxial cable from the Voltage Source to the FREQUENCY INPUT connection on the back of the PPM.

2. Set the Voltage Source to +5.000V.

3. Select the External Frequency input by pressing MENU (3) → F3 → F2 → UNITS → UNITS → GHz

4. Place the system into the Peak Mode by pressing PEAK.

5. The FREQ = XXXX portion of the PPM display must read 5.000 GHz ±0.020 GHz.

D. RF Blanking Output.

1. Connect a coaxial cable from the Scope to the RF BLANKING output on the PPM.

2. Disconnect the Detector from the Signal Generator.

3. The Scope should display a dc level of +5V.

4. Enter the Autozero function by pressing MENU → F3 → F2 → UNITS

5. During the Autozero cycle the Scope display must drop to near 0V, and then return back to +5V.

Miscellaneous

A. Volume Adjust.

1. Adjust the VOLUME ADJ on the back of the PPM fully CCW.

2. Press several keys. Very little (if any) sound should be heard from the speaker.

3. Adjust the VOLUME ADJ fully CW.

4. Press several keys. The various tones should be very easy to hear.

Troubleshooting

Information provided in this section should enable a technician to locate a malfunction and determine specifically which PC board is causing the problem. The instructions given in this section are used to trace a problem to a specific board. Then, the electrical description of the board contained in Chapter 5 (located by referring to the Table of Contents at the front of the manual), and the pertinent schematic diagram (SD) of Chapter 8 (located by referring to the Index for the SD's on page 8-1) can be employed to assist the technician in circuit tracing the bad board. Ensure that devices or components external to the PPM are not the cause of the problem before starting the Troubleshooting procedure.

In general, troubleshooting of the PPM is divided into three parts. First, the display is observed for any error flags (numbers) that might pinpoint the specific faulty section of the circuitry (after performing the Self Test function --- see page 3-31 in the Operation chapter). Second, a known and specific pulse or CW signal is applied and varied as required to allow a general determination of the severity and parameters of the problem. Third, suspect PC boards are placed on extenders, and waveforms and dc voltages indications are traced and checked. Following this initial philosophy, the subsequent steps given in this section can be used to isolate and locate the specific PC board responsible for a particular problem.

Equipment Required

The same equipment as listed on page 7-4 will be required for performing the Troubleshooting procedures given in this section. Additionally, the WMI P/N 17075 Extender Board is needed for troubleshooting the Power Supply PC Board (A2), and the WMI P/N 17076 Extender Board is required for troubleshooting the GPIB/Cal (A3), CPU (A4), Delay (A5), and Analog (A6) PC Boards to component level.

Initial (Power-On) Failure Indications & Possible Causes

1. No indication that the power is turned on when the "ON" button is pressed. (Fan not running and no lights lit on the front panel.)

   a) Ensure that the power cord is plugged into an ac source with the correct voltage and frequency for the PPM. (See Power Requirements on page 2-1 of the Initial Instructions chapter of this manual.)

   b) Check the AC Input Fuse (F1) on the rear panel to be sure that it is in place and not blown.

   c) Ensure that the AC Select Plate is installed in the rear of the instrument.

   d) Ensure that the Power Supply Regulator PC Board (A2) is properly seated in its socket.

   e) Check the Thermal Shut-Off switch located on board A2. (Also, see Step A of the Periodic Maintenance instructions on page 7-1.)

   f) Check the 5V (CR1) and 15V (A1 CR1) Bridge Rectifiers.

2. Front panel apparently works (EL display turns on and lights flash when power is applied), but the fan is not running.

   a) Check the 15V supplies.

   b) Check the fan motor.

   c) Check the Fan Filter Circuit consisting of A1R1 through A1R4, A1 C13, and A1C14.

3. Fan is running, but nothing on the front panel is working.

   a) Check the +5V and -5.2V power supplies.

   b) Ensure that the Front Panel Interface PC Board (A8) is properly seated in its socket.

4. Front panel lights are flashing and EL display is dark.

   a) Ensure that the CPU PC Board (A4) is properly seated in its socket.

   b) Press the RESET button on the rear panel. If this clears the problem, check the output of the Reset Timer (A4U17) for a pulse width of approximately 750 ms when the RESET button is pressed.

   c) Check the 6 MHz CPU clock at A4 TP1.

   d) Check the CPU Halt signal at A4 U12, pin 17 (low digital level = a "Halt" condition).

   e) Check the Address and Data I/O on the CPU at A4U12.

   f) Check the Address Buffers on the PCU at A4U7, A4U8, and A4U9.

   g) Check the Data Buffers on the CPU at A4U32 and A4U33.

   h) Check the Address Decoder on the CPU at A4U34.

   i) Ensure that all of the PROMs on the CPU board are installed in their proper locations.

Self-Test Failure Indications & Possible Causes

Information given in this section assumes that the PPM was working properly when it was initially turned on, that Self-Test was selected, a failure occured, and an Error Number was shown in the instrument's display window. Note that during the Self-Test, all of the front panel LEDs are lit.

Each of the 11 Self-Test checks will be described briefly, and then possible causes of the problem (as indicated by the displayed Error Number pertaining to the specific test) will be listed.

Self-Test #1 (*Error Number 01*): - 5.2V Out of Tolerance

This test applies -5.2V to the Analog A/D Converter (A6U7) through switch A6U13. The -5.2V must be between -4.94 and -5.46V.

a) Check the -5.2V regulator circuit on PC board A2.

b) Check the switches (A6U13C and A6 U20) on the Analog Board (A6).

c) Check the PPI chip (A6U1).

Self-Test #2 (*Error Number 02*): Memory Bad

Performs a "walking ones" test on the volatile RAM. (Clears the memory, then writes and reads a "1" to each memory location. Then writes and reads a "2", etc.)

a) Check the volatile RAM chips A4U5, A4U6, A4U30, and A4U31.

Self-Test #3 (*Error Number 03*): Excessive A Channel Offset

This test sets the A channel Analog PC Board (A6) to its maximum gain of 8192, and measures the total offset voltage present at the input to the Analog A/D Converter (A6U7). The allowable range for the voltage at the input to the Analog PC Board is 0.5 mV which would mean a range of 4.096V at the input to the A/D Converter.

a) Swap the detector and re-run the Self-Test.

b) Check the amplifiers in the Analog PC Board.

c) Check the Analog Switches A6U25, A6U20, A6U15, and A6U13.

d) Check the PPI chip A6U1.

Self-Test #4 (*Error Number 04*): A Channel Gain Error

This Self-Test sets the first variable gain stage to a gain of 8 and measures the offset. Then, 0.5V is applied to the input of the x2 amplifier and the overall gain is measured. The first variable gain stage is then reset to unity gain, and the second stage is tested, then the third, and then the fourth in the same way. The tolerance for each stage is 2% of the gain.

a) Check the amplifiers in the Analog PC Board.

b) Check the Analog Switches A6U22, A6U15, and A6U13.

c) Check the PPI chip A6U1.

Self-Test #5 (*Error Number 05*): Excessive B Channel Offset

Use the same description and Troubleshooting procedures as given in Self-Test #3, above. All reference designations are changed to A7. Applies only to the Model 8502A.

Self-Test #6 (*Error Number 06*): B Channel Gain Error

Use the same description and Troubleshooting procedures as given in Self-Test #4, above. All reference designations are changed to A7. Applies only to the Model 8502A.

Self-Test #7 (*Error Number 07*): A Channel Analog Output DAC

This test routes the output of the Analog Output DAC circuit to the input of the Analog A/D Converter. The DAC is stepped through 81 steps from low to high (each step is 0.1V). The tolerance is 0.5% ±10mV.

a) A6R47 (LIN GAIN) is not adjusted properly. See Analog Output Adjust, Step D, on page 7-6.

b) Check DAC circuit A6U8, A6U14A, and A6U21A.

c) Check analog switches A6U20 and A6U13C.

d) Check the PPI chip A6U1.

e) Check the decoder circuit consisting of A6U2C & D, A6U3C, and A6U5D.

Self-Test #8 (*Error Number 08*): B Channel Analog Output DAC

Use the same description and Troubleshooting procedures as given in Self-Test #7, above. All reference designations are changed to A7. Applies only to the Model 8502A.

Self-Test #9 (*Error Number 09*): Delay 8255s

This test writes a hex "AA" to the first port of A5U6 and reads back the data. It then writes a hex "55" to the same port and reads back the data. These tests are then performed on the remaining two ports of A5U6, and on all three ports of A5U7.

a) Check A5U6 and A5U7.

b) Check A5U4.

c) Check Address Decoder A4U34.

Self-Test #10 (*Error Number 10*): Delay Time Error

This test sets the PPM into the Peak Mode with a delay of 200 ms. It then triggers the delay circuit and measures the time until the delay is complete. The tolerance is 7 ms.

a) Make a thorough check of all circuits on the Digital Delay PC Board (A5).

Self-Test #11 (*Error Number 11*): Calibrator Bridge Voltage Error

This test uses the same software as the Calibration cycle to check the Bridge Voltage.

a) Check A3TP9. Must be between +3 and +10Vdc.

b) Check PPI chip A3U9.

c) Check A3U14, A3U15, A3U10, A3 U13, and A3U18A.

d) Check the Calibrator (A12).

e) Check Address Decoder A4U34.

Input/Output & Calibration Failures

1. The External Trigger input is not functioning.

   a) External Trigger not selected. See External Triggering on page 3-9 of the Operation chapter..

   b) Check A5Q1.

   c) Check A5U31 and A5U30.

   d) Check A5U7.

2. The External Frequency input is not functioning.

   a) The External Frequency input has not been selected. See PROM Frequency Correction on page 3-12 of the Operation chapter..

   b) Check A6U20 (or A7U20 if this is a B channel problem).

   c) Check A6R81, A6R140, and A6C94.

   d) Check A6U1.

3. The SYNC OUTPUT is not functioning.

   NOTE: This is an ECL level pulse that has a pulse width of approximately 20 ns.

   a) Check A5U35C.

4. The RF BLANKING OUTPUT is not functioning properly.

   a) Check A3Q7.
   b) Check A3U8.

5. The MONITOR OUTPUT is not working.

   a) Check A6U30, A6U32 (or A7U30, A7U32 if it is a B channel problem).

6. The PPM passes Self-Test, but fails when attempting to calibrate the detector.

   a) Replace the detector.

   b) Replace the detector cable.

   c) Refer to the GPIB/Cal Control Board instructions on page 7-7 to check the Calibrator output.

CALIBRATION DATA SHEET

NOTE 1: Copies should be made of this sheet before it is used, and kept with the manual. These copies can be utilized when future calibration routines are performed on this unit.

NOTE 2: While continuing step by step through the calibration procedures, if it should be found that any specifications cannot be met by performing the indicated adjustments, immediately go to the Troubleshooting instructions on page 7-11 and follow the procedures given therein.

Date: ______________________

Model 8501A or 8502A PPM S/N: ___________
(cross out one)

Operator: ______________________________

Test Number: __________________ (if required)

Temperature: _________ Humidity: ________

SECTION OF MANUAL	SPECIFICATION	READING	
Regulator Bd. Step A.3	+4.900V to +5.100V		
Regulator Bd. Step A.5	Within 5 mV of A.3 reading		
Regulator Bd. Step B.2	-5.000V to -5.400V		
Regulator Bd. Step B.4	Within 5.2 mV of B.2 reading		
Regulator Bd. Step C.3	-14.985V to -15.015V		
Regulator Bd. Step C.5	Within 15 mV of C.3 reading		
Regulator Bd. Step D.2	+14.955V to +15.045V		
Regulator Bd. Step D.4	Within 15 mV of D.2 reading		
		A6	A7 (8502A only)
Analog Bd. Step A.3	+9.997V to +10.003V		
Analog Bd. Step B.3	-2 mV to +2 mV		
Analog Bd. Step C.2	-1 mV to +1 mV		
Analog Bd. Step D.4	-10 mV to +10 mV		
Analog Bd. Step D.6	+2.975V to +3.025V		
Analog Bd. Step D.8	-4.965V to -5.035V		
Analog Bd. Step E.2	Approx. 5000 mV (±0.2V/°C deviation from 30°C)		

(continued on next page)

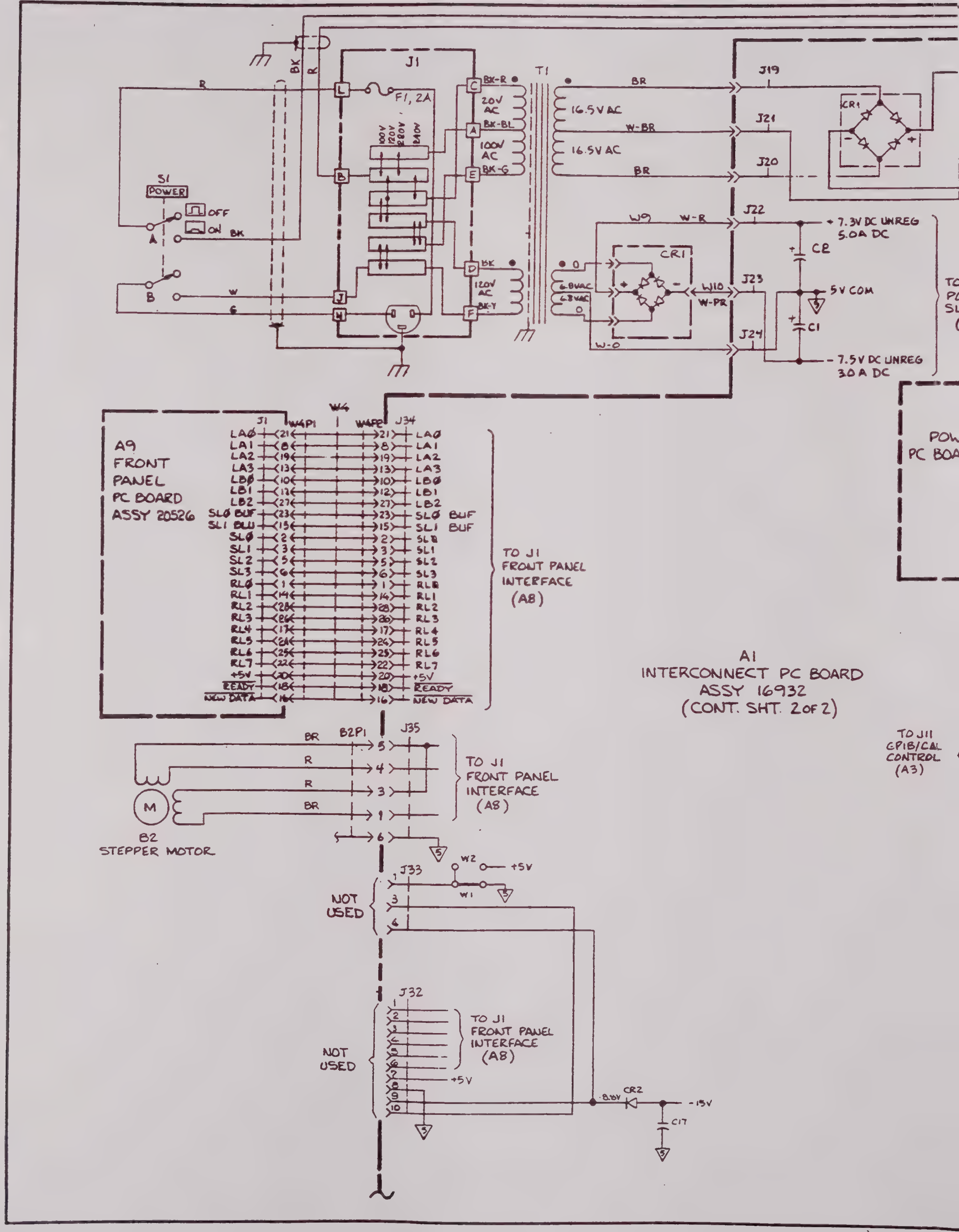
SECTION OF MANUAL	SPECIFICATION	READING
GPIB/Cal Control Bd. Step A.3	950 MHz to 1050 MHz	
CPU Bd. Step A.3	30.517478 to 30.517678 µsec	
Digital Delay Bd. Step A.3	39.062400 to 39.062600 MHz	
External Interface Step C.5	4.98 to 5.02 GHz	
External Interface Step D.3	+5Vdc	
External Interface Step D.5	Approx. 0Vdc	

CHAPTER 8

SCHEMATIC DIAGRAMS (SD) AND ASSEMBLY DRAWINGS

(Component Part Locations)

Reference Designation		Drawing Number	Page Number
	Model 8501A/8502A Peak Power Meter (2 sheets)	20522	8-3
A1	Interconnect PC Board Assy. Dwg. (Fig. 8-1)	16932	8-6
	Interconnect PC Board SD (3 sheets)	21088	8-7
A2	Power Supply PC Board Assy. Dwg. (Fig. 8-2)	16995	8-12
	Power Supply PC Board SD (2 sheets)	16996	8-13
A3	GPIB/Cal Control PC Board Assy. Dwg. (Fig. 8-3)	21014	8-16
	GPIB/CAL Control PC Board SD (2 sheets)	21015	8-17
A4	CPU PC Board Assy. Dwg. (Fig. 8-4)	16878	8-20
	CPU PC Board SD (2 sheets)	16879	8-21
A5	Digital Delay PC Board Assy. Dwg. (Fig. 8-5)	16685	8-24
	Digital Delay PC Board SD (3 sheets)	16686	8-25
A6/A7	Analog PC Board Assy. Dwg. (Fig. 8-6)	20741	8-30
	Analog PC Board SD (3 sheets)	20742	8-31
A8	Front Panel Interface PC Bd. Assy. Dwg. (Fig. 8-7)	20195	8-36
	Front Panel Interface PC Board SD (3 sheets)	20196	8-37
A9	Front Panel PC Board Assy. Dwg. (Fig. 8-8)	20526	8-42
	Front Panel PC Board SD	20527	8-43
A12	Calibrator Assembly SD	17097	8-45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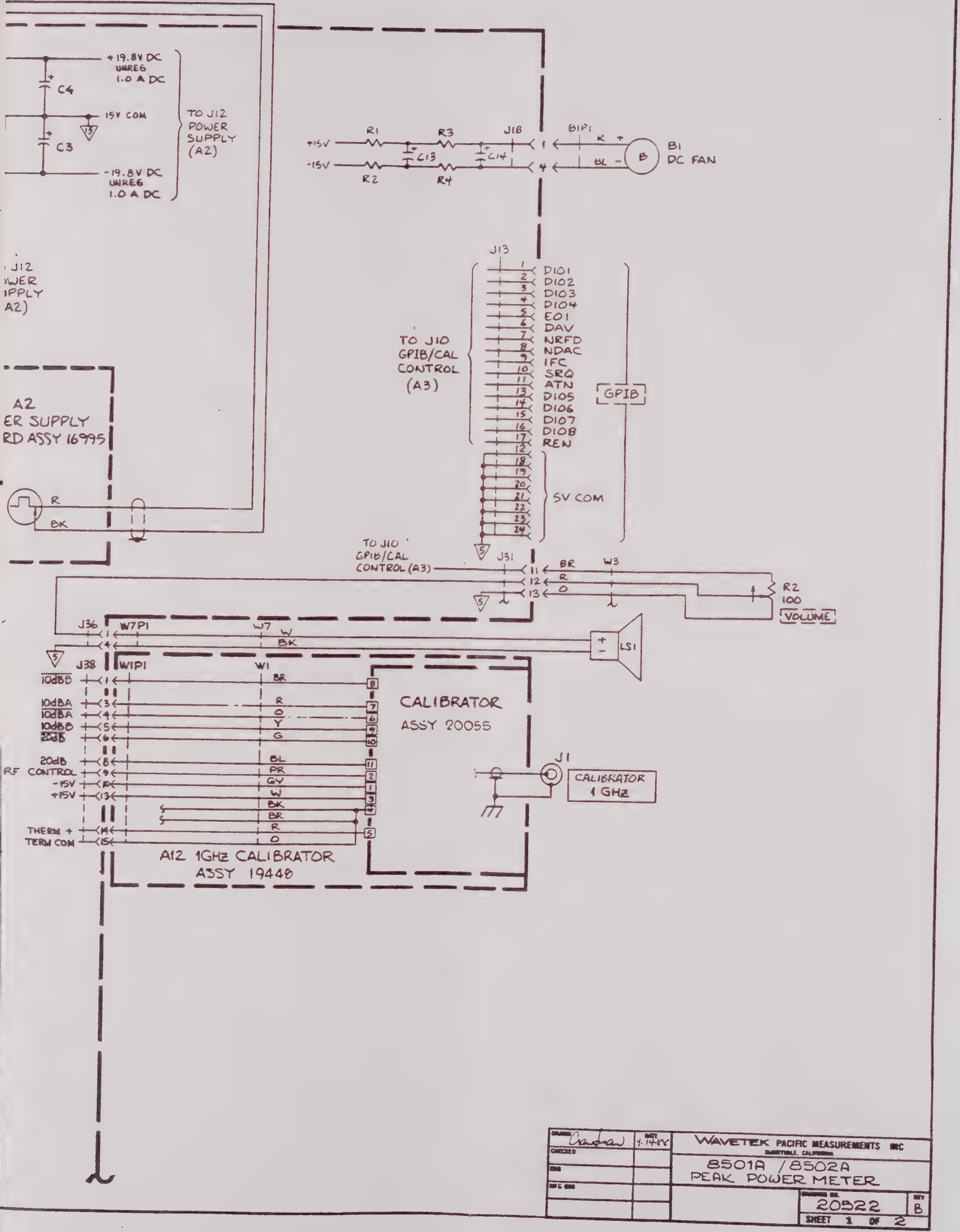
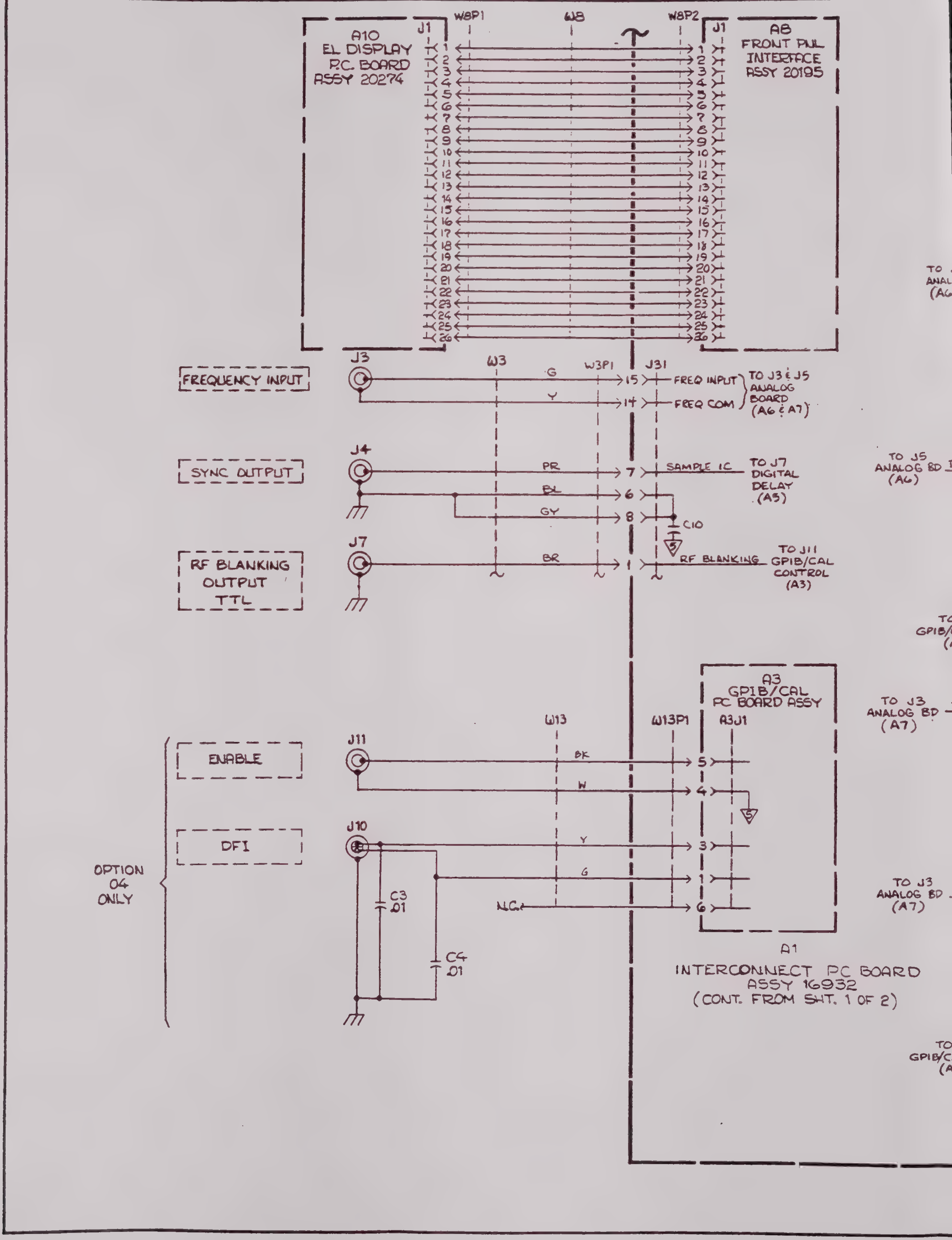
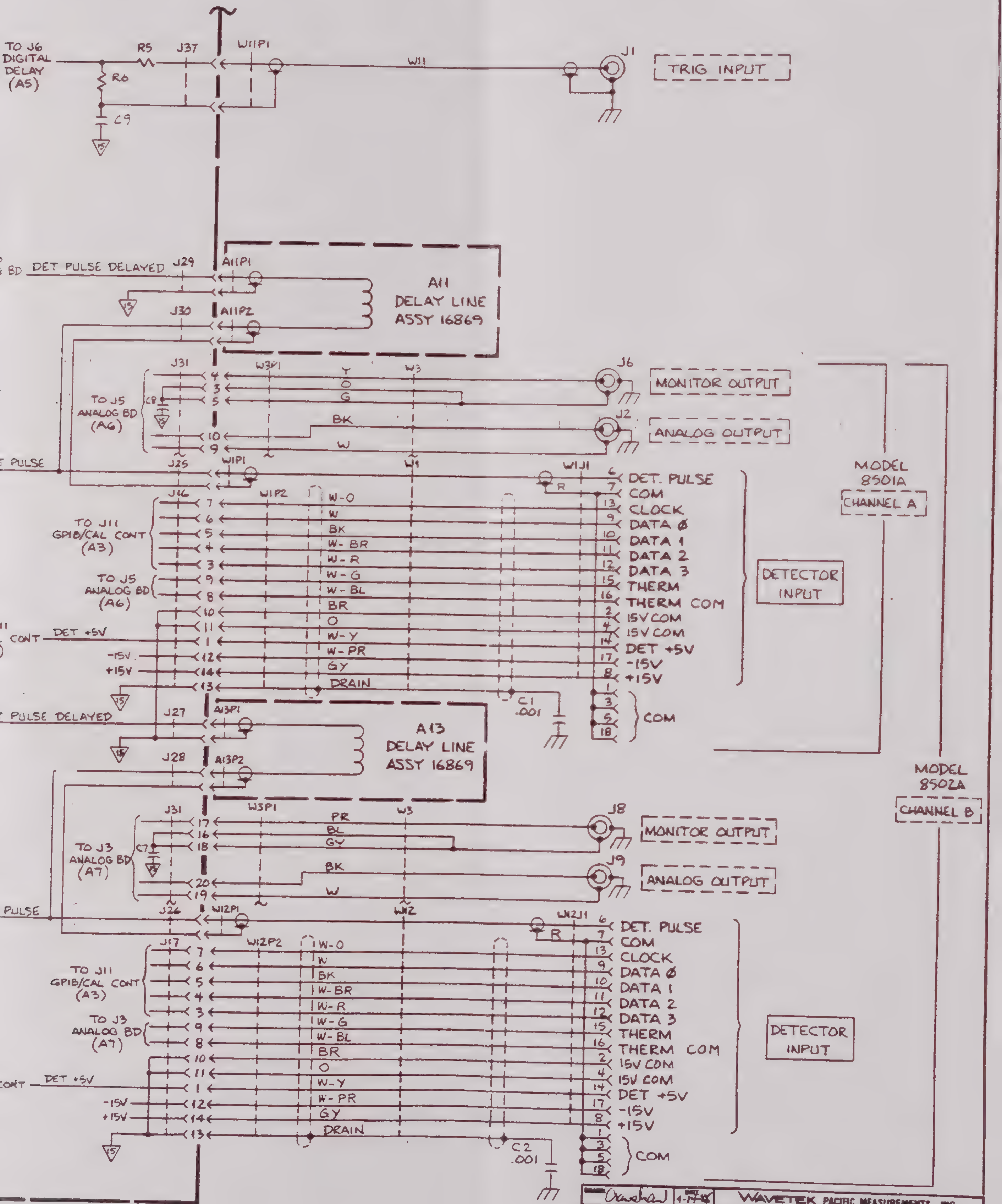
T1
F1, 2A
S1
POWER
OFF
ON
A
B
R
BK
W
G
BK-R
20V AC
BK-BL
100V AC
BK-G
BK
120V AC
BK-Y
100V
120V
220V
240V
16.5V AC
16.5V AC
BR
W-BR
BR
J19
J21
J20
CR1
J22
W9
W-R
+ 7.3V DC UNREG
5.0A DC
C2
CR1
6.3VAC
6.3VAC
W10
W-PR
J23
5V COM
C1
J24
W-O
- 7.5V DC UNREG
3.0 A DC
W4
J1
W4P1
W4P2
J34
A9
FRONT
PANEL
PC BOARD
ASSY 20526
LA0 21 LA0
LA1 8 LA1
LA2 19 LA2
LA3 13 LA3
LB0 10 LB0
LB1 12 LB1
LB2 27 LB2
SL0 BUF 23 SL0 BUF
SL1 BUF 15 SL1 BUF
SL0 2 SL0
SL1 3 SL1
SL2 5 SL2
SL3 6 SL3
RL0 1 RL0
RL1 14 RL1
RL2 28 RL2
RL3 26 RL3
RL4 17 RL4
RL5 24 RL5
RL6 25 RL6
RL7 22 RL7
+5V 20 +5V
READY 18 READY
NEW DATA 16 NEW DATA
TO J1
FRONT PANEL
INTERFACE
(A8)
A1
INTERCONNECT PC BOARD
ASSY 16932
(CONT. SHT. 2 OF 2)
BR
B2P1
J35
R
R
BR
M
B2
STEPPER MOTOR
TO J1
FRONT PANEL
INTERFACE
(A8)
W2
+5V
J33
W1
NOT
USED
J32
TO J1
FRONT PANEL
INTERFACE
(A8)
NOT
USED
+5V
8.2V
CR2
-15V
C17
TO J11
GPIB/CAL
CONTROL
(A3)
POW
PC BOA


+19.8V DC
UNREG
1.0 A DC
C4
15V COM
C3
-19.8V DC
UNREG
1.0 A DC
TO J12
POWER
SUPPLY
(A2)
+15V
-15V
R1
R2
R3
R4
C13
C14
J18
B1P1
K
+
BL
-
B
B1
DC FAN
J12
WER
PPLY
A2)
A2
ER SUPPLY
RD ASSY 16995
R
BK
J13
TO J10
GPIB/CAL
CONTROL
(A3)
1 DIO1
2 DIO2
3 DIO3
4 DIO4
5 EOI
6 DAV
7 NRFD
8 NDAC
9 IFC
10 SRQ
11 ATN
13 DIO5
14 DIO6
15 DIO7
16 DIO8
17 REN
12
18
19
20
21
22
23
24
5V COM
GPIB
5
TO J10
GPIB/CAL
CONTROL (A3)
J31
11
12
13
BR
R
O
W3
R2
100
VOLUME
J36
W7P1
W7
W
BK
1
4
LS1
+
-
J38
W1P1
W1
10dBB
10dBA
10dBA
10dBB
20dB
20dB
RF CONTROL
-15V
+15V
THERM +
TERM COM
BR
R
O
Y
G
BL
PR
GY
W
BK
BR
R
O
8
7
6
9
10
11
2
1
3
4
5
CALIBRATOR
ASSY 20055
J1
CALIBRATOR
1 GHz
A12 1GHz CALIBRATOR
ASSY 19448

DRAWN Crawshaw	DATE 1-14-88	WAVETEK PACIFIC MEASUREMENTS INC SUNNYVALE, CALIFORNIA	
CHECKED		8501A / 8502A PEAK POWER METER	
ENG			
MFG ENG		DRAWING NO. 20922	REV B
		SHEET 1 OF 2	


A10
EL DISPLAY
P.C. BOARD
ASSY 20274
J1
W8P1
W8
W8P2
A8
FRONT PNL
INTERFACE
ASSY 20185
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
FREQUENCY INPUT
J3
W3
W3P1
J31
G
Y
15
14
FREQ INPUT
FREQ COM
TO J3 & J5
ANALOG
BOARD
(A6 & A7)
SYNC OUTPUT
J4
PR
BL
GY
7
6
8
SAMPLE IC
TO J7
DIGITAL
DELAY
(A5)
C10
RF BLANKING
OUTPUT
TTL
J7
BR
1
RF BLANKING
TO J11
GPIB/CAL
CONTROL
(A3)
A3
GPIB/CAL
PC BOARD ASSY
W13
W13P1
A3J1
ENABLE
J11
BK
W
5
4
DFI
J10
Y
G
3
1
6
N.C.
C3
.01
C4
.01
OPTION
04
ONLY
A1
INTERCONNECT PC BOARD
ASSY 16932
(CONT. FROM SHT. 1 OF 2)
TO J5
ANALOG BD
(A6)
TO J3
ANALOG BD
(A7)
TO J3
ANALOG BD
(A7)


TO J6 DIGITAL DELAY (A5)
R5
R6
C9
J37
W11P1
W11
J1
TRIG INPUT
BD
DET PULSE DELAYED
J29
A11P1
J30
A11P2
A11
DELAY LINE
ASSY 16869
J31
W3P1
W3
J6
MONITOR OUTPUT
TO J5 ANALOG BD (A6)
C8
Y
O
G
4
3
5
BK
J2
ANALOG OUTPUT
10
9
W
PULSE
J25
W1P1
W1
W1J1
R
DET. PULSE
COM
CLOCK
DATA 0
DATA 1
DATA 2
DATA 3
THERM
THERM COM
15V COM
15V COM
DET +5V
-15V
+15V
COM
MODEL 8501A
CHANNEL A
J16
W1P2
TO J11 GPIB/CAL CONT (A3)
TO J5 ANALOG BD (A6)
W-O
W
BK
W-BR
W-R
W-G
W-BL
BR
O
W-Y
W-PR
GY
DRAIN
CONT
DET +5V
-15V
+15V
C1
.001
DETECTOR INPUT
PULSE DELAYED
J27
A13P1
J28
A13P2
A13
DELAY LINE
ASSY 16869
MODEL 8502A
CHANNEL B
J31
W3P1
W3
J8
MONITOR OUTPUT
TO J3 ANALOG BD (A7)
C7
PR
BL
GY
17
16
18
BK
J9
ANALOG OUTPUT
20
19
W
PULSE
J26
W12P1
W12
W12J1
R
DET. PULSE
COM
CLOCK
DATA 0
DATA 1
DATA 2
DATA 3
THERM
THERM COM
15V COM
15V COM
DET +5V
-15V
+15V
COM
J17
W12P2
TO J11 GPIB/CAL CONT (A3)
TO J3 ANALOG BD (A7)
CONT
DET +5V
-15V
+15V
C2
.001
DETECTOR INPUT

DRAWN | DATE 4-17-78
CHECKED
ENG
MFG ENG

WAVETEK PACIFIC MEASUREMENTS INC
SUNNYVALE, CALIFORNIA

8501A / 8502A
PEAK POWER METER

DRAWING NO. 20522 | REV B
SHEET 2 OF 2

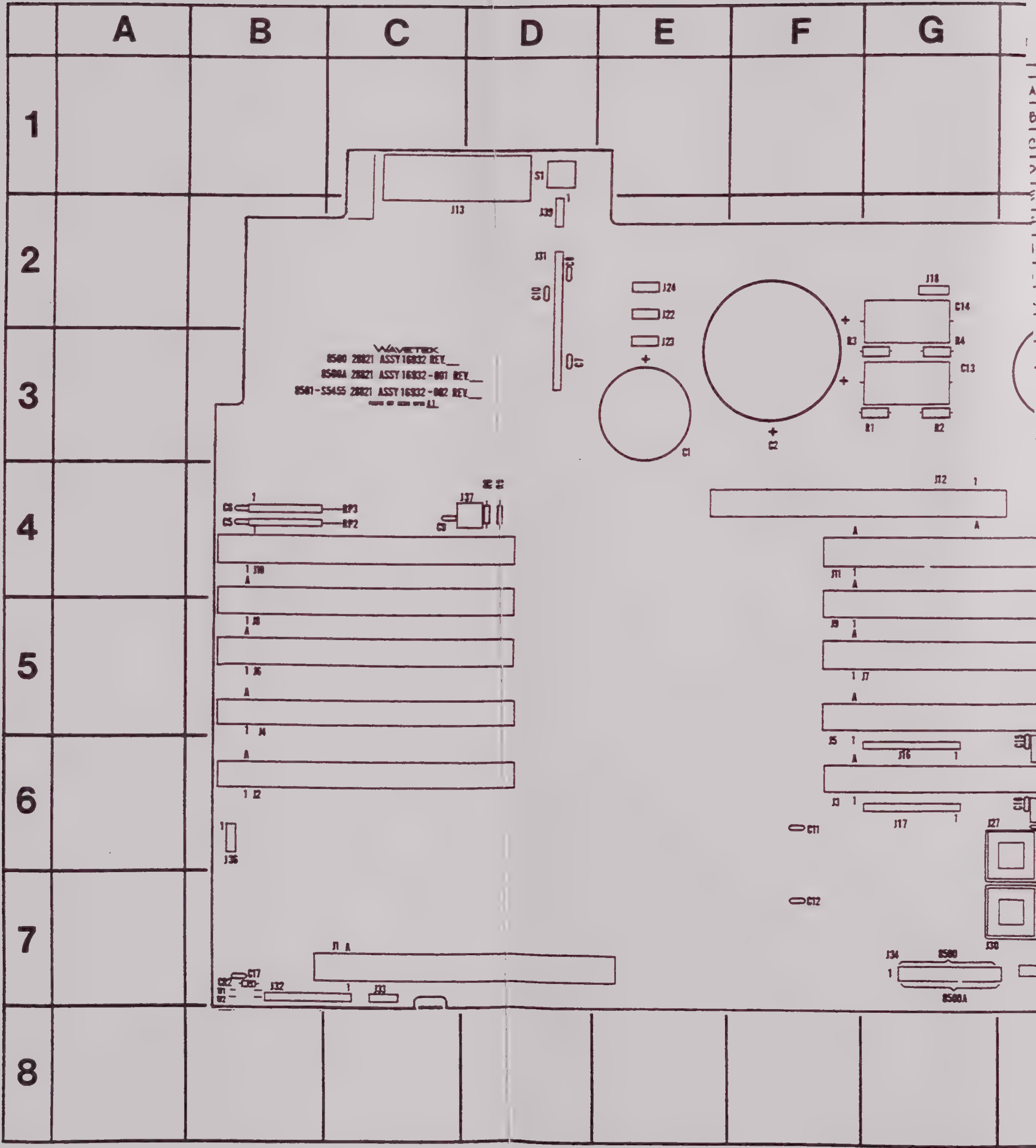
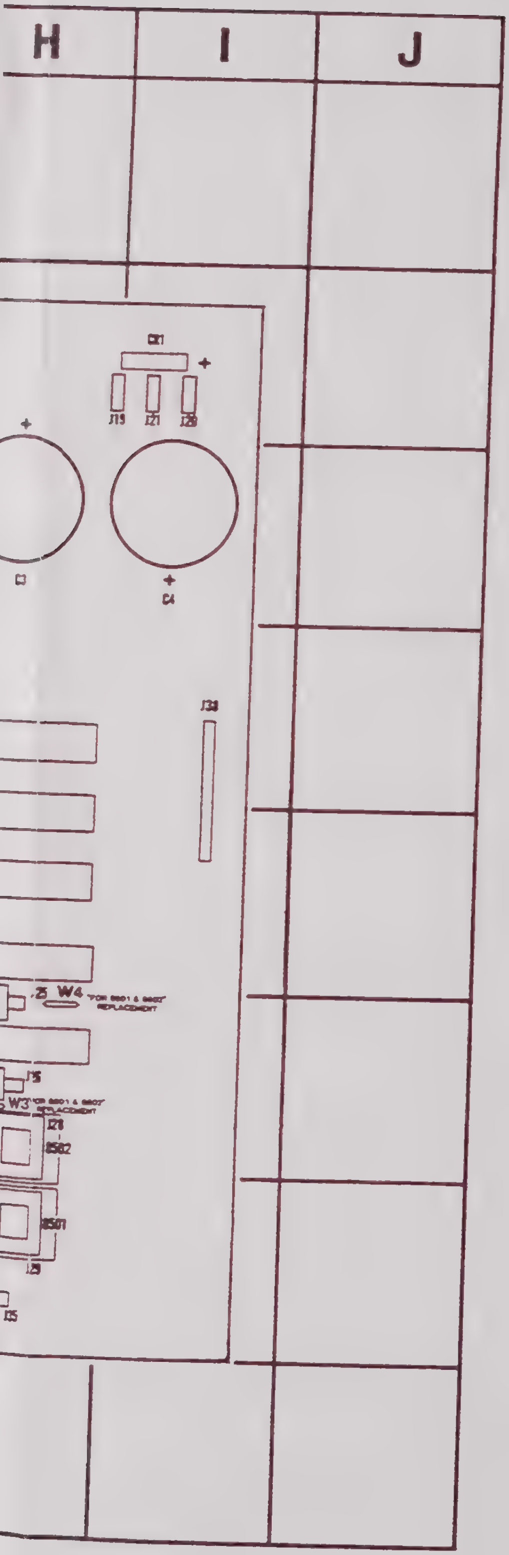
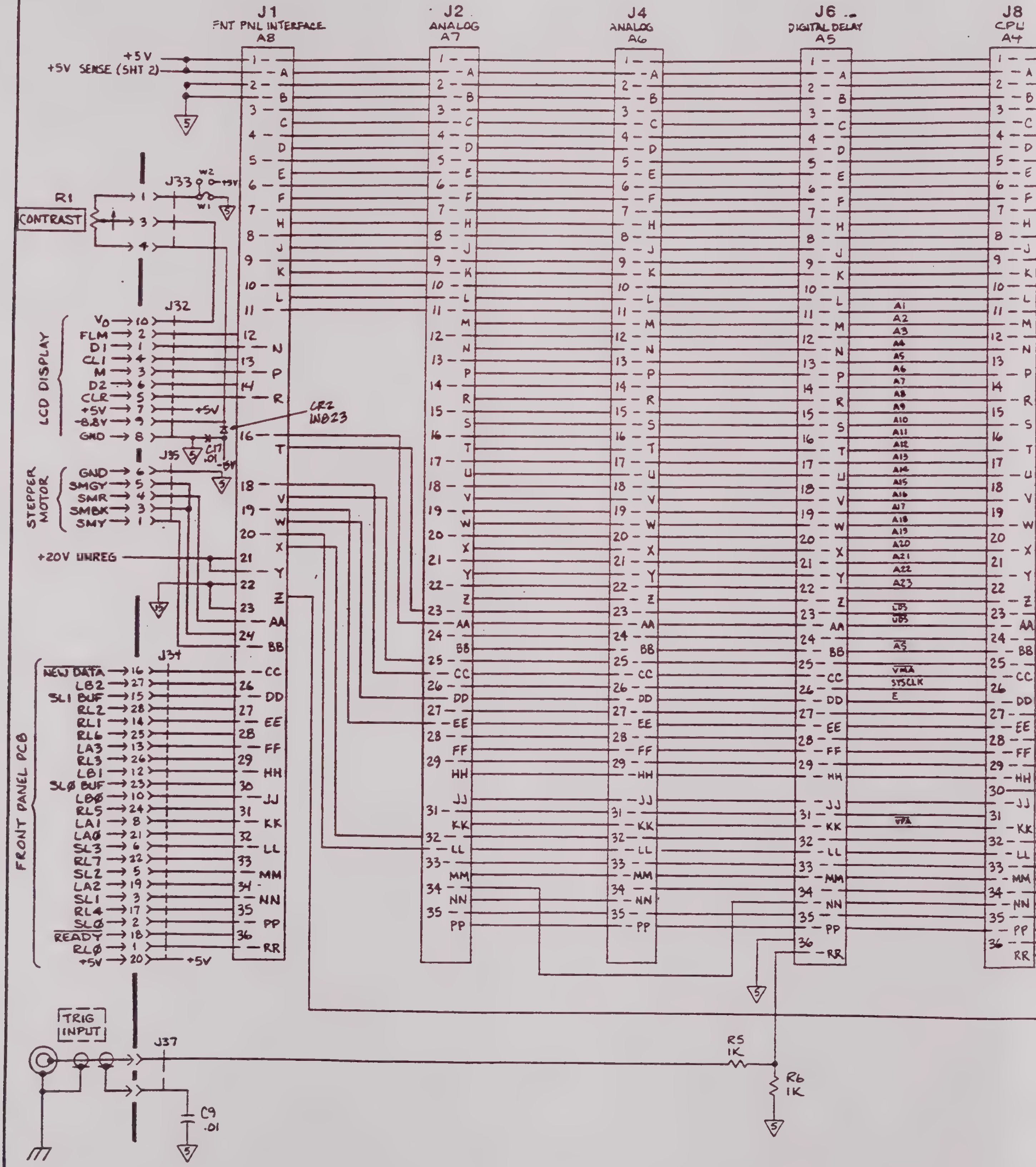
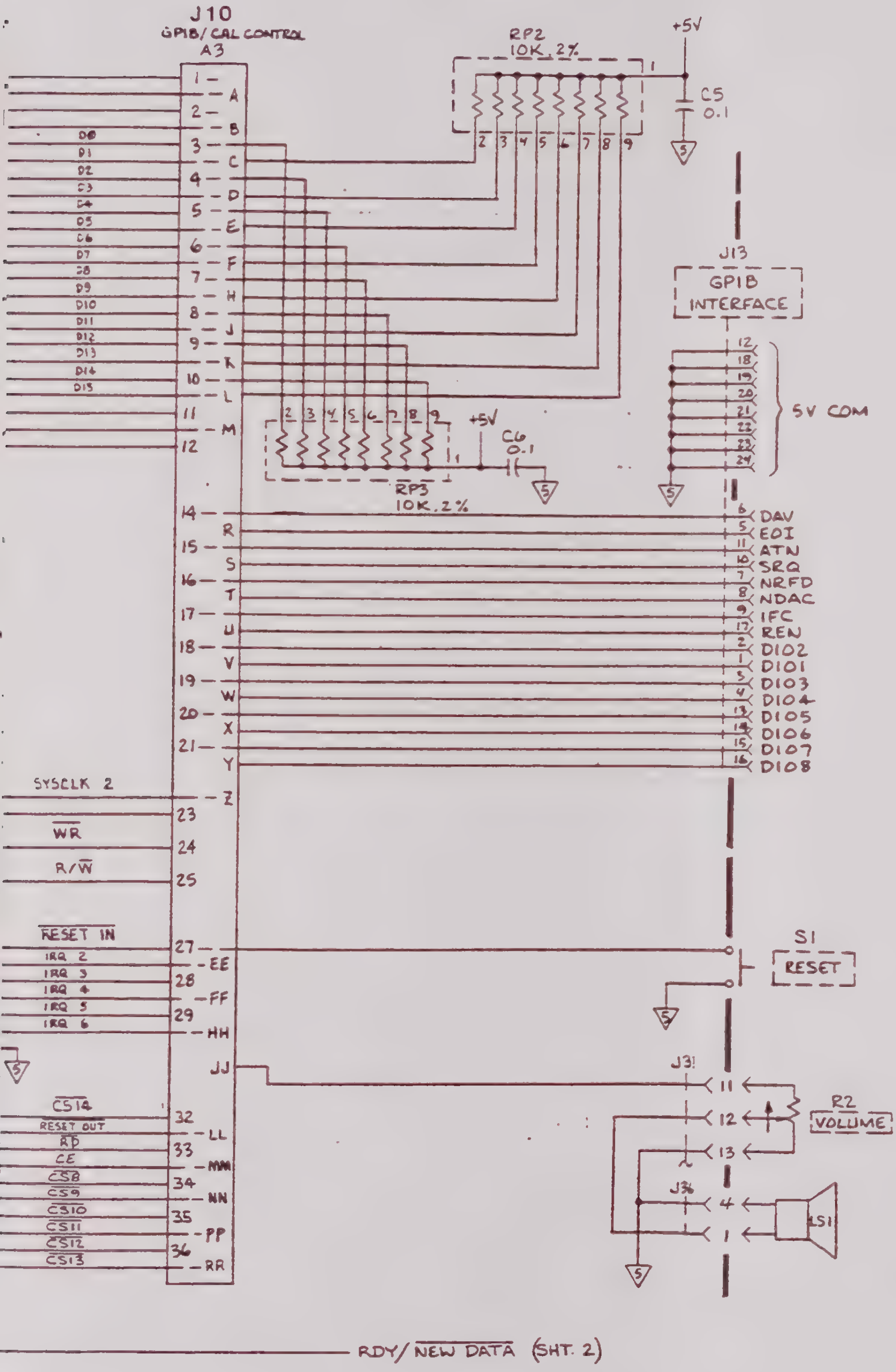

A
B
C
D
E
F
G
1
2
3
4
5
6
7
8
WAVETEK
8500 28821 ASSY 16932 REV__
8500A 28821 ASSY 16932-001 REV__
8501-55455 28821 ASSY 16932-002 REV__
J13
S1
J39
J31
C10
C9
C7
J24
J22
J23
C1
C2
J18
C14
R3
R4
C13
R1
R2
J12
J37
C3
C6
C5
RP3
RP2
J10
J8
J6
J4
J2
J11
J9
J7
J5
J16
J3
J17
C11
C12
J27
J36
J1
C17
J32
J33
J34
8500
8500A
J30

Figure 8-1 Interconnect PCB Assembly #16932


H
I
J
CR1
J19
J21
J28
C3
C4
J38
W4
REPLACEMENT
W3
REPLACEMENT

CKT REF	GRID LOC	CKT REF	GRID LOC
C1	E-3	J28	H-6
C2	F-3	J29	H-7
C3	H-3	J30	H-7
C4	I-3	J31	D-2
C5	B-4	J32	B-7
C6	B-4	J33	C-7
C7	D-3	J34	G-7
C8	D-2	J35	H-7
C9	C-4	J36	B-6
C10	D-2	J37	D-4
C11	F-6	J38	I-4
C12	F-7	J39	D-2
C13	G-3		
C14	G-2	R1	G-3
C15	H-6	R2	G-3
C16	H-6	R3	G-3
C17	B-7	R4	G-3
		R5	D-4
CR1	I-2	R6	D-4
CR2	B-7		
		RP1	
J1	C-7	RP2	B-4
J2	B-6	RP3	B-4
J3	F-6		
J4	B-5	S1	D-1
J5	F-5		
J6	B-5	W1	H-6
J7	F-5	W2	H-6
J8	B-5		
J9	F-5		
J10	B-4		
J11	F-4		
J12	G-4		
J13	C-1		
J14			
J15			
J16	G-6		
J17	G-6		
J18	G-2		
J19	H-2		
J20	I-2		
J21	I-2		
J22	E-2		
J23	E-3		
J24	E-2		
J25	H-6		
J26	H-6		
J27	H-6		

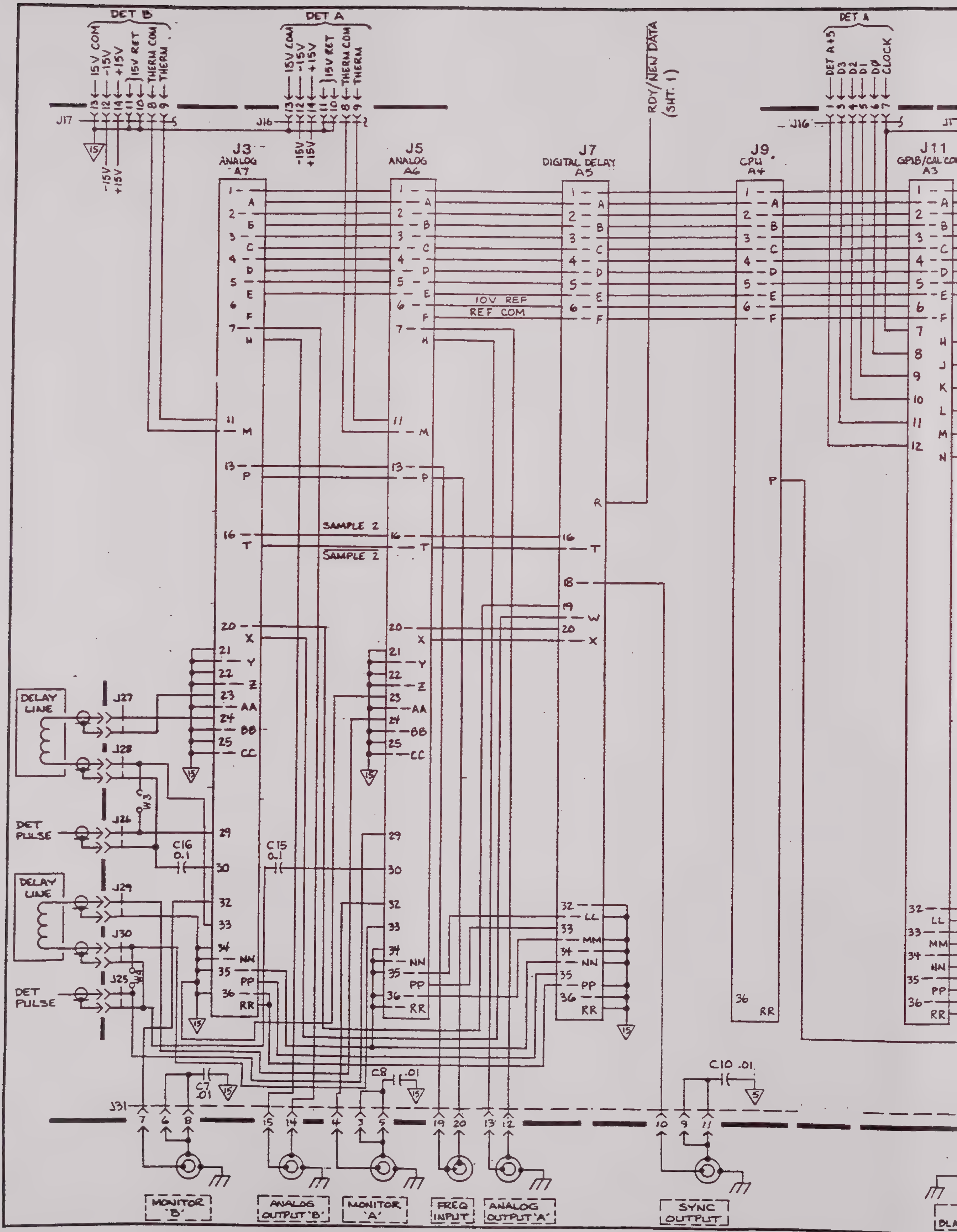

J1
FNT PNL INTERFACE
A8
J2
ANALOG
A7
J4
ANALOG
A6
J6
DIGITAL DELAY
A5
J8
CPU
A4
+5V
+5V SENSE (SHT 2)
R1
CONTRAST
J33
W2
W1
+5V
J32
LCD DISPLAY
V0 → 10
FLM → 2
D1 → 1
CL1 → 4
M → 3
D2 → 6
CLR → 5
+5V → 7
-8.8V → 9
GND → 8
+5V
CR2
1N823
C17
.01
-5V
J35
STEPPER MOTOR
GND → 6
SMGY → 5
SMR → 4
SMBK → 3
SMY → 1
+20V UNREG
J34
FRONT PANEL PCB
NEW DATA → 16
LB2 → 27
SL1 BUF → 15
RL2 → 28
RL1 → 14
RL6 → 25
LA3 → 13
RL3 → 26
LB1 → 12
SLØ BUF → 23
LBØ → 10
RL5 → 24
LA1 → 8
LAØ → 21
SL3 → 6
RL7 → 22
SL2 → 5
LA2 → 19
SL1 → 3
RL4 → 17
SLØ → 2
READY → 18
RLØ → 1
+5V → 20
+5V
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
A16
A17
A18
A19
A20
A21
A22
A23
LDS
UDS
AS
VMA
SYSCLK
E
VPA
TRIG INPUT
J37
C9
.01
R5
1K
R6
1K
5

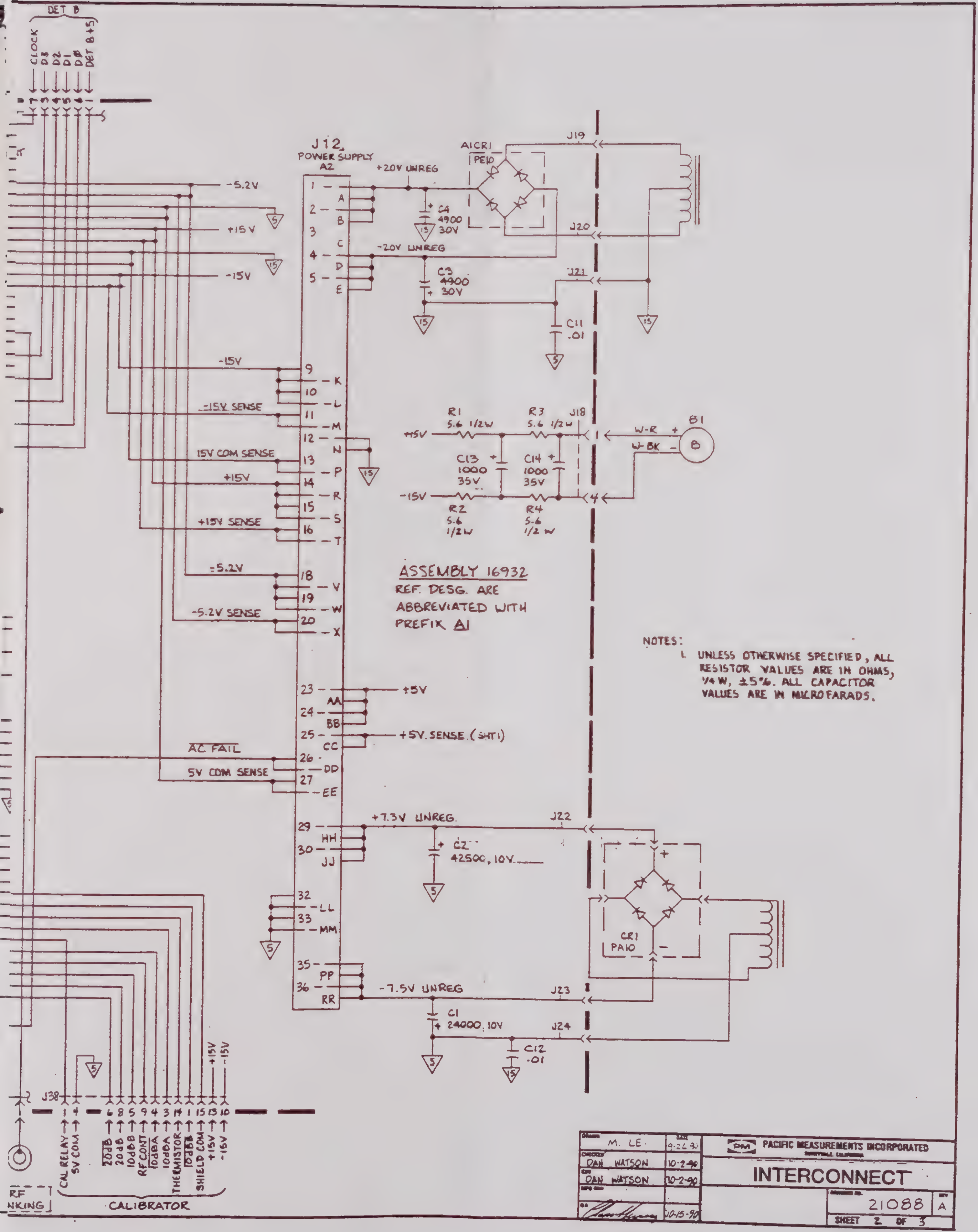

J10
GPIB/CAL CONTROL
A3
RP2
10K 2%
+5V
C5
0.1
D0
D1
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
D12
D13
D14
D15
1
2
3
4
5
6
7
8
9
10
11
12
14
15
16
17
18
19
20
21
23
24
25
27
28
29
32
33
34
35
36
A
B
C
D
E
F
H
J
K
L
M
R
S
T
U
V
W
X
Y
Z
EE
FF
HH
JJ
LL
MM
NN
PP
RR
J13
GPIB
INTERFACE
5V COM
+5V
C6
0.1
RP3
10K 2%
DAV
EOI
ATN
SRQ
NRFD
NDAC
IFC
REN
DIO2
DIO1
DIO3
DIO4
DIO5
DIO6
DIO7
DIO8
SYSCLK 2
WR
R/W
RESET IN
IRQ 2
IRQ 3
IRQ 4
IRQ 5
IRQ 6
S1
RESET
J31
R2
VOLUME
CS14
RESET OUT
RD
CE
CS8
CS9
CS10
CS11
CS12
CS13
J36
LS1
RDY/NEW DATA (SHT. 2)

NOTES:
1. UNLESS OTHERWISE SPECIFIED, ALL CAPACITOR VALUES ARE IN MICROFARADS. ALL RESISTOR VALUES ARE IN OHMS ¼ W, ±5%.
2. POTENTIOMETER ARROW INDICATES CW ROTATION.

ASSEMBLY 16932
REF. DESIG. ARE ABBREVIATED WITH PREFIX A1

DRAWN M. LE	9-26-90	PM PACIFIC MEASUREMENTS INCORPORATED SUNNYVALE, CALIFORNIA
CHECKED DAN WATSON	10-2-90	INTERCONNECT
ENG DAN WATSON	10-2-90	
APPROVED TIM LOWE	10-02-90	DRAWING NO. 21088 REV A
QA	10-15-90	SHEET 1 OF 3


DET B
15V COM
-15V
+15V
15V RET
THERM COM
THERM
J17
-15V
+15V
DET A
15V COM
-15V
+15V
15V RET
THERM COM
THERM
J16
-15V
+15V
RDY/NEW DATA
(SHT. 1)
DET A
DET A+5
D3
D2
D1
DØ
CLOCK
J16
J3
ANALOG
A7
J5
ANALOG
A6
J7
DIGITAL DELAY
A5
J9
CPU
A4
J11
GPIB/CAL CO
A3
10V REF
REF COM
SAMPLE 2
SAMPLE 2
DELAY LINE
J27
J28
W3
DET PULSE
J26
C16
0.1
C15
0.1
DELAY LINE
J29
J30
W4
J25
DET PULSE
C7
.01
C8
.01
C10 .01
J31
MONITOR 'B'
ANALOG OUTPUT 'B'
MONITOR 'A'
FREQ INPUT
ANALOG OUTPUT 'A'
SYNC OUTPUT
BLA


DET B
CLOCK
D3
D2
D1
D0
DET B+5
J12
POWER SUPPLY
A2
+20V UNREG
A1CR1
PE10
J19
J20
J21
C4
4900
30V
-20V UNREG
C3
4900
30V
C11
.01
-5.2V
+15V
-15V
-15V SENSE
15V COM SENSE
+15V
+15V SENSE
-5.2V
-5.2V SENSE
AC FAIL
5V COM SENSE
R1
5.6 1/2W
R3
5.6 1/2W
J18
+15V
-15V
C13
1000
35V
C14
1000
35V
R2
5.6
1/2W
R4
5.6
1/2W
B1
W-R
W-BK
B
+5V
+5V SENSE (SHT 1)
+7.3V UNREG.
J22
C2
42500, 10V
CR1
PA10
-7.5V UNREG
J23
C1
24000, 10V
J24
C12
.01
J38
CAL RELAY
5V COM
20dB
20dB
10dBB
RF CONT
10dBA
10dBA
THERMISTOR
10dBB
SHIELD COM
+15V
-15V
RF
NKING
CALIBRATOR

ASSEMBLY 16932
REF. DESG. ARE
ABBREVIATED WITH
PREFIX A1

NOTES:
1. UNLESS OTHERWISE SPECIFIED, ALL RESISTOR VALUES ARE IN OHMS, 1/4 W, ±5%. ALL CAPACITOR VALUES ARE IN MICROFARADS.

DRAWN	M. LE	9-26-90
CHECKED	DAN WATSON	10-2-90
ENG	DAN WATSON	10-2-90
QA		10-15-90

PACIFIC MEASUREMENTS INCORPORATED

INTERCONNECT

21088 A

SHEET 2 OF 3

MODEL 8500 INTERCONNECT

P1 PIN NO.	J1 FRONT PANEL INTERFACE A8	J2 ANALOG (SPARE) A7	J4 ANALOG A6	J6 DIGITAL DELAY A5	J8 CPU A4	J10 GPIB / CAL CONTROLLER A3	P1 ← PIN NUMBER P2 →	J3 ANALO (SPARE)
A	+5V	+5V	+5V	+5V	+5V	+5V	A	-5.2V
1	+5V	+5V	+5V	+5V	+5V	+5V	1	-5.2V
B	5V COM	5V COM	5V COM	5V COM	5V COM	5V COM	B	5V COM
2	5V COM	5V COM	5V COM	5V COM	5V COM	5V COM	2	5V COM
C	D1	D1	D1	D1	D1	D1	C	+15V
3	D0	D0	D0	D0	D0	D0	3	+15V
D	D3	D3	D3	D3	D3	D3	D	15V CO
4	D2	D2	D2	D2	D2	D2	4	15V CO
E	D5	D5	D5	D5	D5	D5	E	-15V
5	D4	D4	D4	D4	D4	D4	5	-15V
F	D7	D7	D7	D7	D7	D7	F	REF COM
6	D6	D6	D6	D6	D6	D6	6	10V REF
H	D9	D9	D9	D9	D9	D9	H	ANALOG OUTPU
7	D8	D8	D8	D8	D8	D8	7	ANALOG CO
J	D11	D11	D11	D11	D11	D11	J	
8	D10	D10	D10	D10	D10	D10	8	
K	D13	D13	D13	D13	D13	D13	K	
9	D12	D12	D12	D12	D12	D12	9	
L	D15	D15	D15	D15	D15	D15	L	
10	D14	D14	D14	D14	D14	D14	10	
M		A2	A2	A2	A2	A2	M	THERM COM
11	A1	A1	A1	A1	A1	A1	11	THERM (
N	LCD-D1	A4	A4	A4	A4		N	
12	LCD-FLM	A3	A3	A3	A3	A3	12	
P	LCD-M	A6	A6	A6	A6		P	FREQ INPUT
13	LCD-CL1	A5	A5	A5	A5		13	FREQ COMM
R	LCD-CLR	A8	A8	A8	A8		R	
14	LCD-D2	A7	A7	A7	A7		14	
S		A10	A10	A10	A10		S	
15		A9	A9	A9	A9		15	
T	$\overline{\text{LDS}}$	A12	A12	A12	A12		T	SAMPLE 2
16	$\overline{\text{UDS}}$	A11	A11	A11	A11		16	SAMPLE 1
U		A14	A14	A14	A14		U	
17		A13	A13	A13	A13		17	
V	R/$\overline{\text{W}}$	A16	A16	A16	A16		V	
18	$\overline{\text{VMA}}$	A15	A15	A15	A15		18	
W	E	A18	A18	A18	A18		W	
19	$\overline{\text{IRQ2}}$	A17	A17	A17	A17		19	
X	$\overline{\text{CS14}}$	A20	A20	A20	A20		X	SAMPLE 1
20	$\overline{\text{RESET OUT}}$	A19	A19	A19	A19		20	SAMPLE 1
Y	+20V UNREG	A22	A22	A22	A22		Y	15V COM
21	+20V UNREG	A21	A21	A21	A21		21	15V COM
Z	RDY/$\overline{\text{NEW DATA}}$	SYS CLK/2	SYS CLK/2	SYS CLK/2	SYS CLK/2	SYS CLK/2	Z	15V COM
22	15V COM	A23	A23	A23	A23		22	15V COM
AA	SMR	$\overline{\text{UDS}}$	$\overline{\text{UDS}}$	$\overline{\text{UDS}}$	$\overline{\text{UDS}}$		AA	15V COM
23	15V COM	$\overline{\text{LDS}}$	$\overline{\text{LDS}}$	$\overline{\text{LDS}}$	$\overline{\text{LDS}}$	$\overline{\text{LDS}}$	23	DET COM
BB	SMY	$\overline{\text{AS}}$	$\overline{\text{AS}}$	$\overline{\text{AS}}$	$\overline{\text{AS}}$		BB	15V COM
24	SMBK/SMGY	$\overline{\text{WR}}$	$\overline{\text{WR}}$	$\overline{\text{WR}}$	$\overline{\text{WR}}$	$\overline{\text{WR}}$	24	DET PULSE DE
CC	$\overline{\text{NEW DATA}}$	$\overline{\text{VMA}}$	$\overline{\text{VMA}}$	$\overline{\text{VMA}}$	$\overline{\text{VMA}}$		CC	15V COM
25		R/$\overline{\text{W}}$	R/$\overline{\text{W}}$	R/$\overline{\text{W}}$	R/$\overline{\text{W}}$	R/$\overline{\text{W}}$	25	15V COM
DD	SL1 BUF	E	E	E	E		DD	
26	LB2	SYS CLK	SYS CLK	SYS CLK	$\overline{\text{CPU HALT}}$		26	
EE	RL1	$\overline{\text{IRQ 2}}$	$\overline{\text{IRQ 2}}$	$\overline{\text{IRQ 2}}$	$\overline{\text{IRQ 2}}$		EE	
27	RL2	$\overline{\text{RESET IN}}$	$\overline{\text{RESET IN}}$	$\overline{\text{RESET IN}}$	$\overline{\text{RESET IN}}$	$\overline{\text{RESET IN}}$	27	
FF	LA3	$\overline{\text{IRQ 4}}$	$\overline{\text{IRQ 4}}$	$\overline{\text{IRQ 4}}$	$\overline{\text{IRQ 4}}$	$\overline{\text{IRQ 4}}$	FF	
28	RL6	$\overline{\text{IRQ 3}}$	$\overline{\text{IRQ 3}}$	$\overline{\text{IRQ 3}}$	$\overline{\text{IRQ 3}}$	$\overline{\text{IRQ 3}}$	28	
HH	LB1	$\overline{\text{IRQ 6}}$	$\overline{\text{IRQ 6}}$	$\overline{\text{IRQ 6}}$	$\overline{\text{IRQ 6}}$	$\overline{\text{IRQ 6}}$	HH	
29	RL3	$\overline{\text{IRQ 5}}$	$\overline{\text{IRQ 5}}$	$\overline{\text{IRQ 5}}$	$\overline{\text{IRQ 5}}$	$\overline{\text{IRQ 5}}$	29	DET PULS
JJ	LB0				$\overline{\text{CS7}}$	SPKR	JJ	
30	SL0 BUF				5V COM		30	
KK	LA1	$\overline{\text{VPA}}$	$\overline{\text{VPA}}$	$\overline{\text{VPA}}$	$\overline{\text{VPA}}$		KK	
31	RL5				$\overline{\text{DTACK}}$		31	
LL	SL3	$\overline{\text{RESET OUT}}$	$\overline{\text{RESET OUT}}$	$\overline{\text{RESET OUT}}$	$\overline{\text{RESET OUT}}$	$\overline{\text{RESET OUT}}$	LL	
32	LA0	$\overline{\text{CS14}}$	$\overline{\text{CS14}}$	$\overline{\text{CS14}}$	$\overline{\text{CS14}}$	$\overline{\text{CS14}}$	32	MONITOR C
MM	SL2	CE	CE	CE	CE	CE	MM	
33	RL7	$\overline{\text{RD}}$	$\overline{\text{RD}}$	$\overline{\text{RD}}$	$\overline{\text{RD}}$	$\overline{\text{RD}}$	33	
NN	SL1	$\overline{\text{CS9}}$	$\overline{\text{CS9}}$	$\overline{\text{CS9}}$	$\overline{\text{CS9}}$	$\overline{\text{CS9}}$	NN	15V COM
34	LA2	$\overline{\text{CS8}}$	$\overline{\text{CS8}}$	$\overline{\text{CS8}}$	$\overline{\text{CS8}}$	$\overline{\text{CS8}}$	34	15V COM
PP	SL0	$\overline{\text{CS11}}$	$\overline{\text{CS11}}$	$\overline{\text{CS11}}$	$\overline{\text{CS11}}$	$\overline{\text{CS11}}$	PP	TRIG E
35	RL4	$\overline{\text{CS10}}$	$\overline{\text{CS10}}$	$\overline{\text{CS10}}$	$\overline{\text{CS10}}$	$\overline{\text{CS10}}$	35	15V COM
RR	RL0			TRIG INPUT	$\overline{\text{CS13}}$	$\overline{\text{CS13}}$	RR	15V COM
36	$\overline{\text{READY}}$			5V COM	$\overline{\text{CS12}}$	$\overline{\text{CS12}}$	36	15V COM

PC BOARD

G A7	J5 ANALOG A6	J7 DIGITAL DELAY A5	J9 CPU A4	J11 GPIB / CAL CONTROLLER A3	J12 POWER SUPPLY A2	P2 PIN NO.
	-5.2V -5.2V	-5.2V -5.2V	-5.2 V -5.2 V	-5.2V -5.2V	+20V UNREG +20V UNREG	A 1
	5V COM 5V COM	5V COM 5V COM	5V COM 5V COM	5 V COM 5V COM	+20V UNREG +20V UNREG	B 2
	+ 15V +15V	+15V +15V	+15V +15V	+ 15V +15V		C 3
M M	15V COM 15V COM	15V COM 15V COM	15V COM 15V COM	15V COM 15V COM	-20V UNREG -20V UNREG	D 4
	-15V -15V	-15V -15V	-15V -15V	-15V -15V	-20V UNREG -20V UNREG	E 5
	REF COM 10V REF	REF COM 10V REF	REF COM 10V REF	REF COM 10V REF		F 6
T (B) M	ANALOG OUTPUT (A) ANALOG COM			RF BLANKING DET CLOCK		H 7
				DET-B D3 DET-A D0		J 8
				DET-B D2 DET-A D1	-15V -15V	K 9
				DET-B D1 DET-A D2	-15V -15V	L 10
(B))	THERM COM (A) THERM (A)			DET-B D0 DET-A D3	-15V SENSE -15V SENSE	M 11
				DET-B +5V SWITCHED DET-A +5V SWITCHED	15 V COM 15 V COM	N 12
B) DM	FREQ INPUT (A) FREQ COMMON		$\overline{\text{ACFAIL}}$		15V COM SENSE 15V COM SENSE	P 13
		RDY/$\overline{\text{NEW DATA}}$			+15V +15V	R 14
					+15V +15V	S 15
	$\overline{\text{SAMPLE 2}}$ SAMPLE 2	$\overline{\text{SAMPLE 2}}$ SAMPLE 2			+15V SENSE +15V SENSE	T 16
		$\overline{\text{SAMPLE 1D}}$ SAMPLE 1D				U 17
		$\overline{\text{SAMPLE 1C}}$ SAMPLE 1C			-5.2V -5.2V	V 18
		$\overline{\text{SAMPLE 1B}}$ SAMPLE 1B			-5.2V -5.2V	W 19
B)	$\overline{\text{SAMPLE 1A}}$ SAMPLE 1A	$\overline{\text{SAMPLE 1A}}$ SAMPLE 1A			-5.2V SENSE -5.2V SENSE	X 20
	15V COM 15V COM					Y 21
	15V COM 15V COM					Z 22
	15V COM DET COM				+5V +5V	AA 23
AYED	15V COM DET PULSE DELAYED				+5V +5V	BB 24
	15V COM 15V COM				+5V SENSE +5V SENSE	CC 25
					$\overline{\text{AC FAIL}}$ $\overline{\text{AC FAIL}}$	DD 26
					5V COM SENSE 5V COM SENSE	EE 27
						FF 28
	DET PULSE				+7.3V UNREG +7.3V UNREG	HH 29
					+7.3V UNREG +7.3V UNREG	JJ 30
						KK 31
T	MONITOR OUT	15V COM 15V COM		$\overline{\text{10 dBB}}$ SHIELD COM	5V COM 5V COM	LL 32
		15V COM TRIG A		10 dBA THERMISTOR	5V COM 5V COM	MM 33
	15V COM 15V COM	15V COM 15V COM		$\overline{\text{10 dBA}}$ CAL RELAY		NN 34
	TRIG A 15V COM	15V COM TRIG B		10 dBB RF CONT	-7.5V UNREG. -7.5V UNREG	PP 35
	15V COM 15V COM	15V COM 15V COM		$\overline{\text{20 dB}}$ 20 dB	-7.5V UNREG -7.5V UNREG	RR 36

M. LE	9-26-90	PACIFIC MEASUREMENTS INCORPORATED SUNNYVALE, CALIFORNIA
DAN WATSON	10-2-90	INTERCONNECT
DAN WATSON	10-2-90	
		21088 A
	10-15-90.	SHEET 3 OF 3

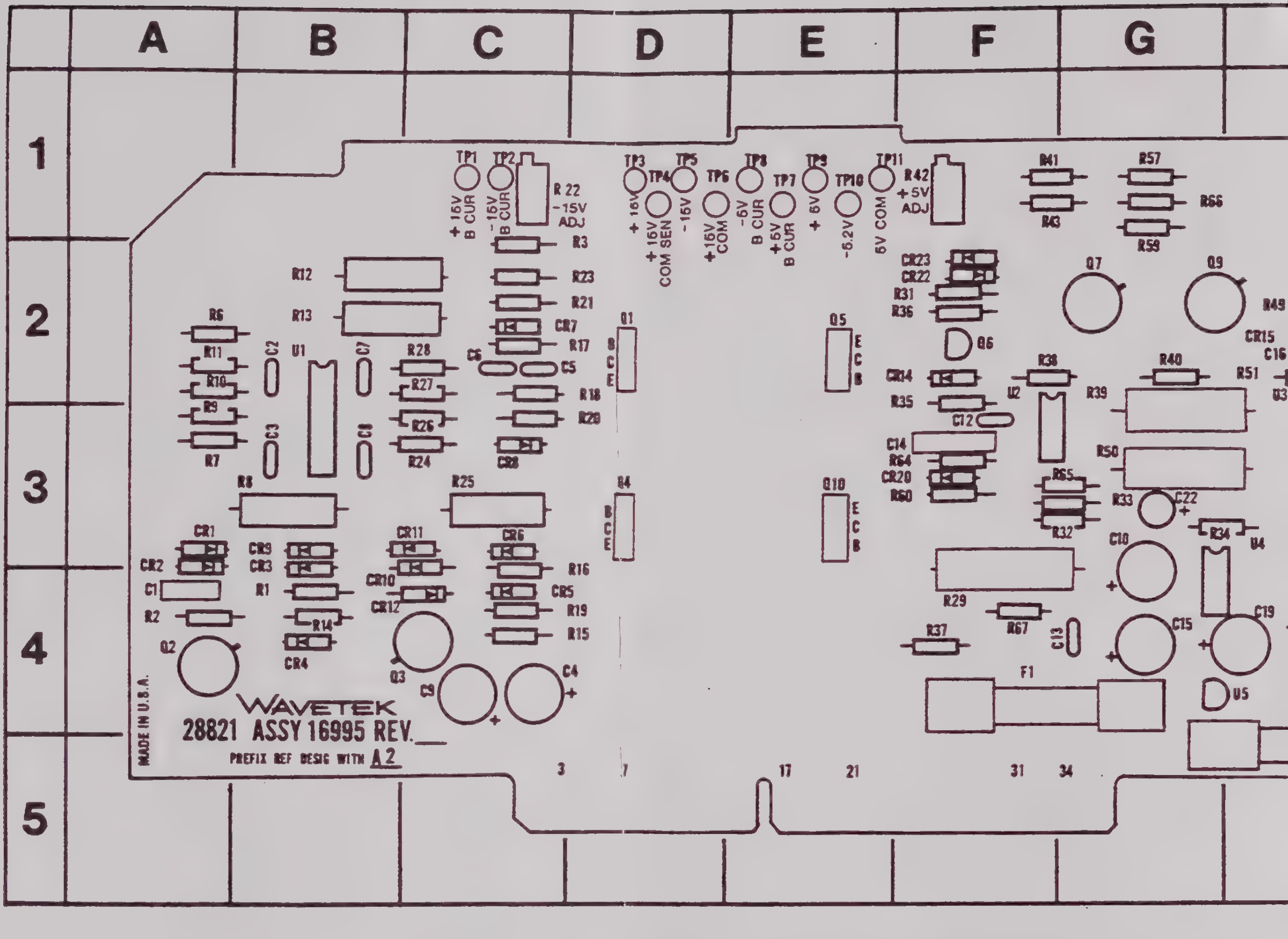
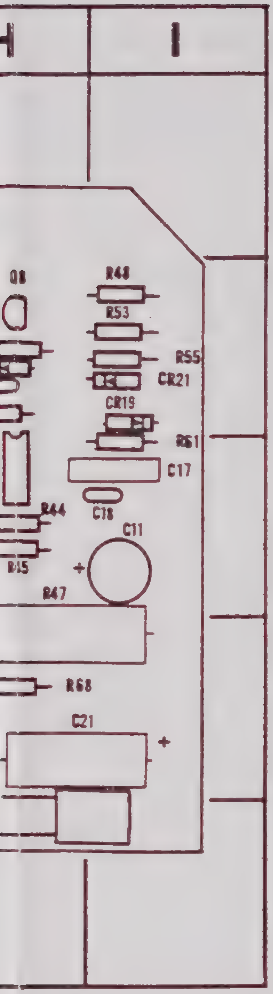
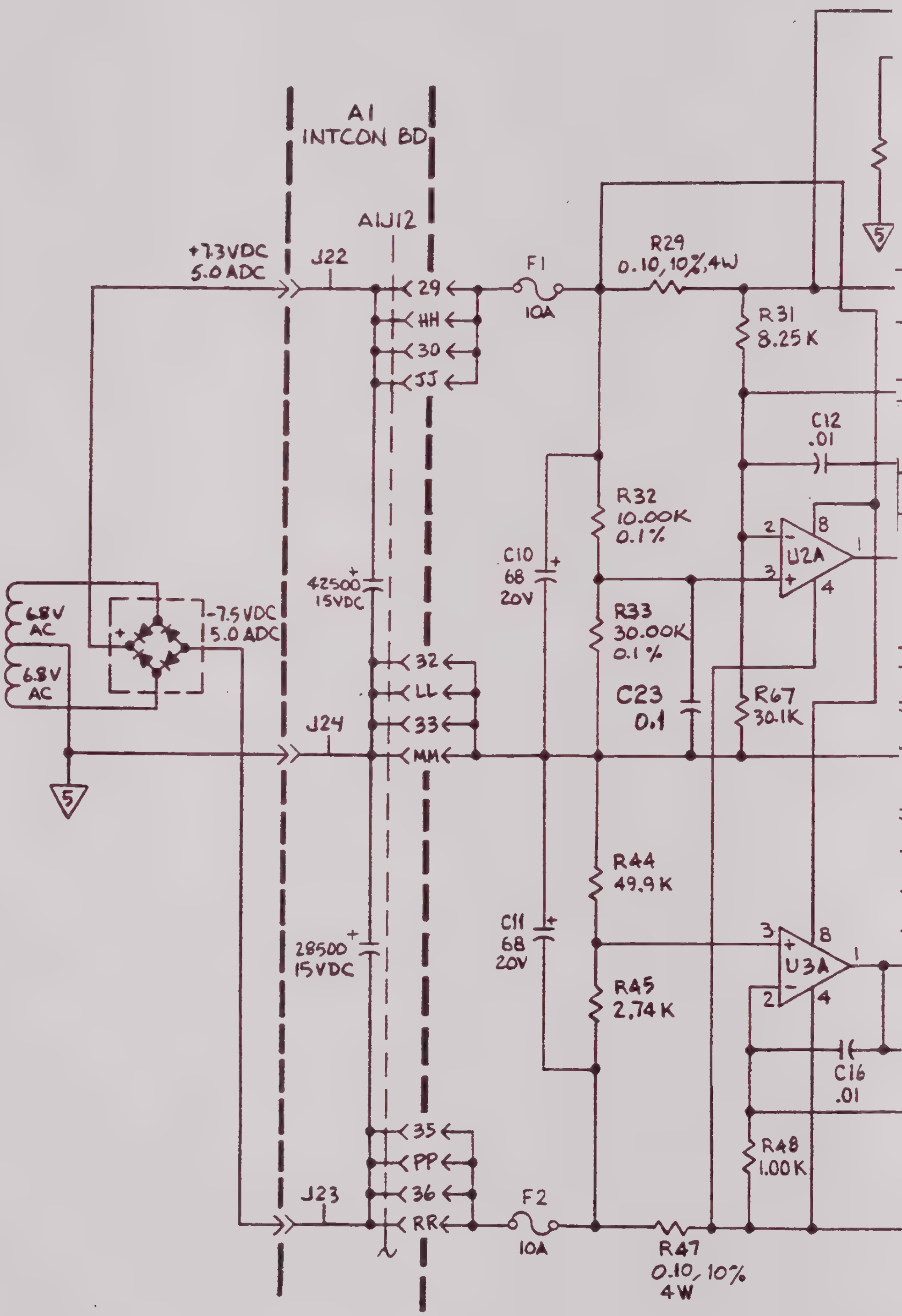

A
B
C
D
E
F
G
1
2
3
4
5
TP1
TP2
+16V B CUR
-16V B CUR
R 22 -15V ADJ
TP3
TP4
TP5
TP6
TP8
TP7
TP9
TP10
TP11
+16V
+16V COM SEN
-15V
+16V COM
-6V B CUR
+5V B CUR
+6V
-6.2V
5V COM
R42 +5V ADJ
WAVETEK
28821 ASSY 16995 REV.__
PREFIX REF DESIG WITH A2
MADE IN U.S.A.
3
7
17
21
31
34

Figure 8-2 Power Supply PCB Assembly #16995

CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
C1	A-4	CR1	A-3	CR23	F-2	R6	A-2	R28	C-2	R50	G-3	TP1	C-1
C2	B-2	CR2	A-3			R7	A-3	R29	F-4	R51	H-2	TP2	C-1
C3	B-3	CR3	B-4	F1	F-4	R8	B-3	R30		R52		TP3	D-1
C4	C-4	CR4	B-4	F2	H-5	R9	A-3	R31	F-2	R53	I-2	TP4	D-1
C5	C-2	CR5	C-4			R10	A-2	R32	G-3	R54		TP5	D-1
C6	C-2	CR6	C-3	Q1	D-2	R11	A-2	R33	G-3	R55	I-2	TP6	D-1
C7	B-2	CR7	C-2	Q2	A-4	R12	B-2	R34	G-3	R56		TP7	E-1
C8	B-3	CR8	C-3	Q3	C-4	R13	B-2	R35	F-3	R57	G-1	TP8	E-1
C9	C-4	CR9	B-3	Q4	D-3	R14	B-4	R36	F-2	R58		TP9	E-1
C10	G-3	CR10	C-4	Q5	E-2	R15	C-4	R37	F-4	R59	G-1	TP10	E-1
C11	I-3	CR11	C-3	Q6	F-2	R16	C-4	R38	F-2	R60	F-3	TP11	E-1
C12	F-3	CR12	C-4	Q7	G-2	R17	C-2	R39	G-3	R61	I-3		
C13	G-4	CR13		Q8	H-2	R18	C-2	R40	G-2	R62			
C14	F-3	CR14	F-2	Q9	G-2	R19	C-4	R41	F-1	R63			
C15	G-4	CR15	H-2	Q10	E-3	R20	C-3	R42	F-1	R64	F-3	U1	B-2
C16	H-2	CR16				R21	C-2	R43	F-1	R65	G-3	U2	F-3
C17	I-3	CR17				R22	C-1	R44	H-3	R66	G-1	U3	H-3
C18	I-3	CR18		R1	B-4	R23	C-2	R45	H-3	R67	F-4	U4	G-4
C19	H-4	CR19	I-2	R2	A-4	R24	C-3	R46		R68	H-4	U5	G-4
C20		CR20	F-3	R3	C-2	R25	C-3	R47	H-4				
C21	H-4	CR21	I-2	R4		R26	C-3	R48	I-2				
C22	G-3	CR22	F-2	R5		R27	C-2	R49	H-2				


H
I
Q8
R48
R53
R55
CR21
CR19
R61
C17
C18
R44
C11
+
R45
R47
R68
C21
+


A1
INTCON BD
A1J12
+7.3VDC
5.0 ADC
J22
29
HH
30
JJ
F1
10A
R29
0.10, 10%, 4W
R31
8.25 K
C12
.01
R32
10.00K
0.1%
C10
68
20V
2
8
U2A
1
3
4
R33
30.00K
0.1%
C23
0.1
R67
30.1K
6.8V
AC
6.8V
AC
-7.5VDC
5.0 ADC
42500
15VDC
32
LL
33
MM
J24
5
5
R44
49.9 K
C11
68
20V
3
8
U3A
1
2
4
28500
15VDC
R45
2.74 K
C16
.01
R48
1.00 K
35
PP
36
RR
J23
F2
10A
R47
0.10, 10%
4W

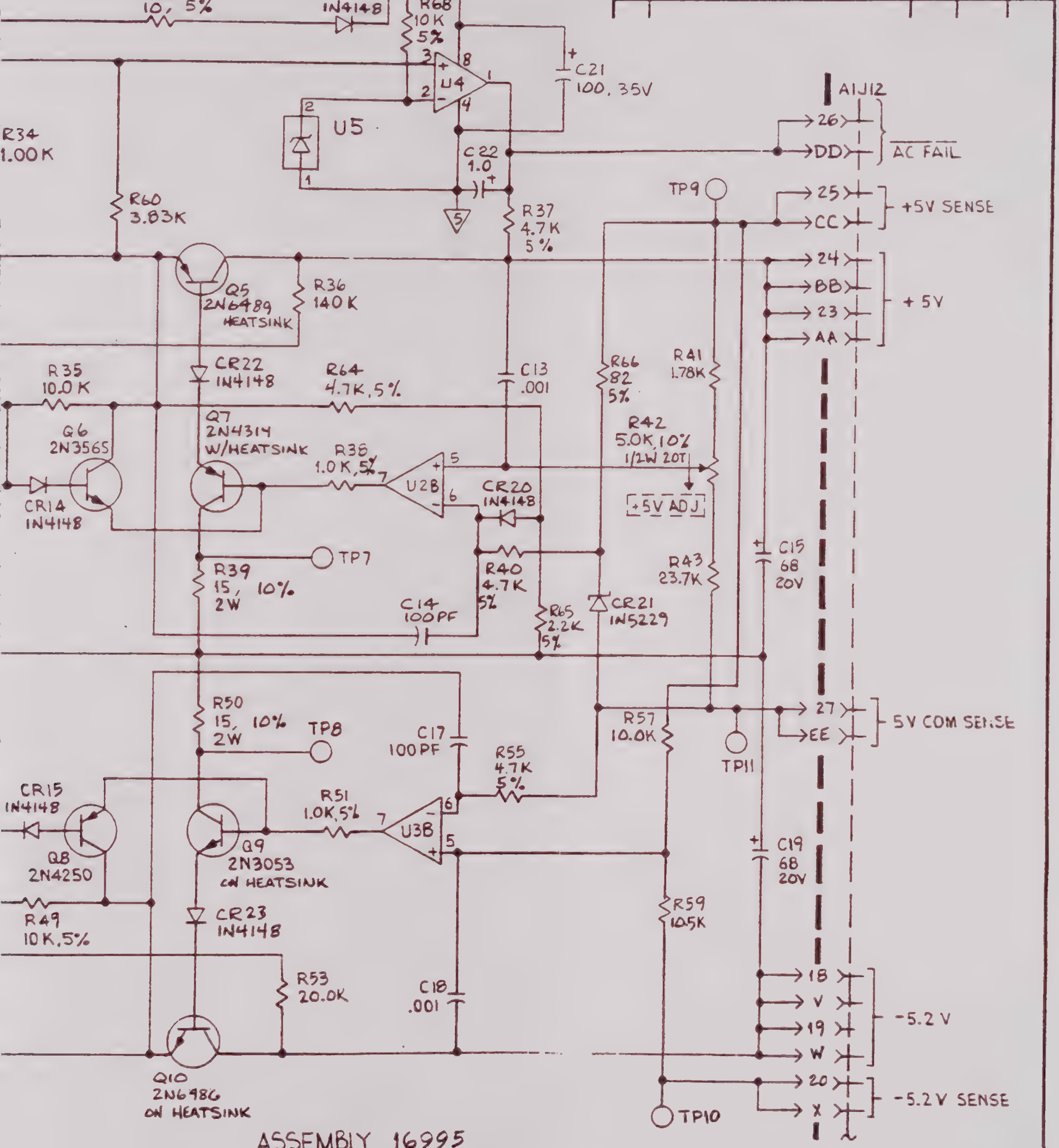
NOTES (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTOR VALUES ARE IN OHMS, 1/4W, ± 1%.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.
3. POTENTIOMETER ARROW INDICATES CW ROTATION.

U5
U4
U2, U3
REF DES

DIETERICH POST RECORDER NO. 87939

SYM	REVISION	ECO	DATE	APPD


R61
10, 5%
CR19
1N4148
R68
10K
5%
U4
C21
100, 35V
A1J12
26
DD
AC FAIL
R34
1.00K
U5
C22
1.0
TP9
25
CC
+5V SENSE
R60
3.83K
R37
4.7K
5%
24
BB
23
AA
+5V
Q5
2N6489
HEATSINK
R36
140K
CR22
1N4148
R35
10.0K
R64
4.7K, 5%
C13
.001
R66
82
5%
R41
1.78K
Q6
2N3565
Q7
2N4314
W/HEATSINK
R38
1.0K, 5%
U2B
R42
5.0K, 10%
1/2W 20T
+5V ADJ
CR14
1N4148
CR20
1N4148
TP7
C15
68
20V
R39
15, 10%
2W
R40
4.7K
5%
R43
23.7K
C14
100PF
R65
2.2K
5%
CR21
1N5229
R50
15, 10%
2W
TP8
C17
100PF
R57
10.0K
27
EE
5V COM SENSE
TP11
CR15
1N4148
R55
4.7K
5%
R51
1.0K, 5%
U3B
Q8
2N4250
Q9
2N3053
ON HEATSINK
C19
68
20V
R49
10K, 5%
CR23
1N4148
R59
10.5K
R53
20.0K
C18
.001
18
V
19
W
-5.2V
20
X
-5.2V SENSE
Q10
2N6486
ON HEATSINK
TP10

ASSEMBLY 16995
REFERENCE DESIGNATORS ARE ABBREVIATED
WITH PREFIX A2

ITEM	REQD	PART NO.	DESCRIPTION

LIST OF MATERIAL

NEXT ASSY

	LM385-1.2
	LM393
	LM358
IG	TYPE

FINISH OR TREATMENT
—

UNLESS OTHERWISE INDICATED
DIMENSIONS ARE IN INCHES
TOLERANCE
.XX = .015
.XXX = .005
ANGLE = 1/2°
63√

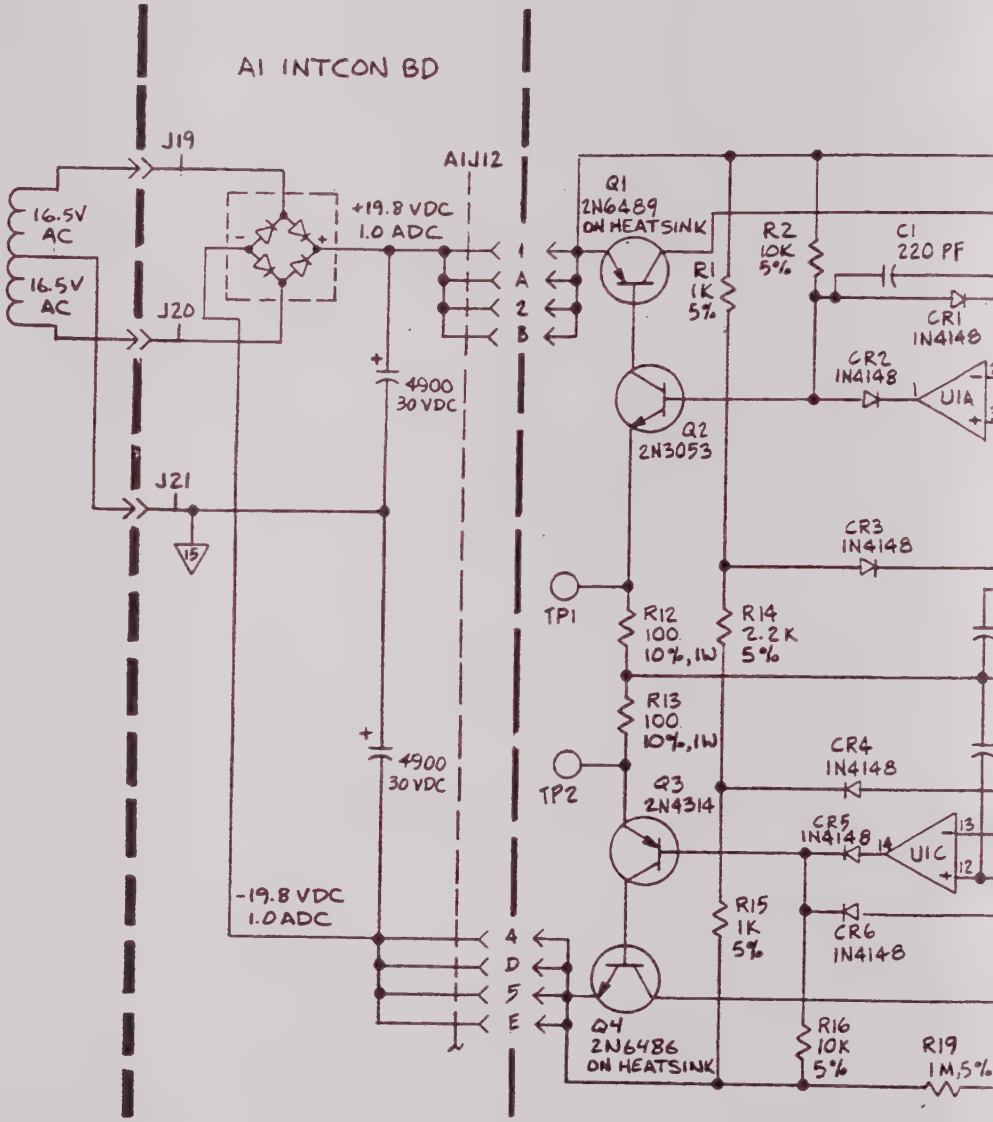
SCALE —

DRAWN	E. DROZD	5-24-84
CHECKED		3-5-87
ENG		3-5-87
MFG ENG		3-5-87
QA		3-6-87

WAVETEK PACIFIC MEASUREMENTS, INC.
SUNNYVALE, CALIFORNIA

POWER SUPPLY

DRAWING NO. 16996
REV E
SHEET 1 OF 2


A1 INTCON BD
J19
J20
J21
A1J12
16.5V AC
16.5V AC
+19.8 VDC
1.0 ADC
-19.8 VDC
1.0 ADC
+
4900
30 VDC
+
4900
30 VDC
15
1
A
2
B
4
D
5
E
Q1
2N6489
ON HEATSINK
Q2
2N3053
Q3
2N4314
Q4
2N6486
ON HEATSINK
R1
1K
5%
R2
10K
5%
C1
220 PF
CR1
1N4148
CR2
1N4148
U1A
CR3
1N4148
TP1
TP2
R12
100
10%, 1W
R13
100
10%, 1W
R14
2.2K
5%
CR4
1N4148
CR5
1N4148
U1C
13
12
14
CR6
1N4148
R15
1K
5%
R16
10K
5%
R19
1M, 5%

NOTES: (UNLESS OTHERWISE SPECIFIED)

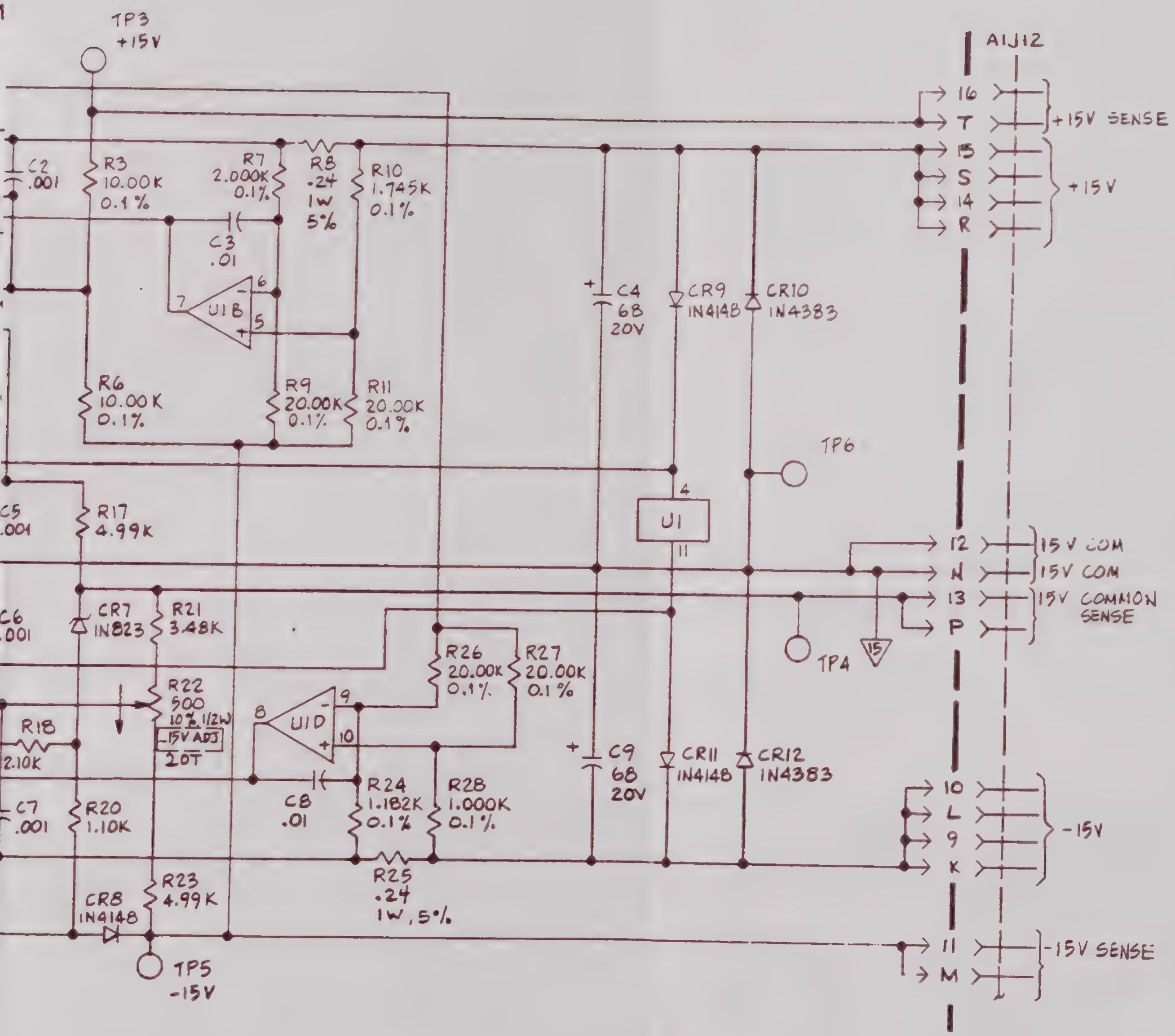
1. ALL RESISTOR VALUES ARE IN OHMS, 1/4 W, ± 1%.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.
3. POTENTIOMETER ARROW INDICATES CW ROTATION.

U1

REF D

DIETRICH POST REORDER NO. 82939

SYM	REVISION	ECO	DATE	APPD


TP3
+15V
C2
.001
R3
10.00K
0.1%
R7
2.000K
0.1%
R8
.24
1W
5%
R10
1.745K
0.1%
C3
.01
7
U1B
6
5
R6
10.00K
0.1%
R9
20.00K
0.1%
R11
20.00K
0.1%
C4
68
20V
CR9
IN4148
CR10
IN4383
TP6
4
U1
11
A1J12
16
T
15
S
14
R
+15V SENSE
+15V
12
N
13
P
15V COM
15V COM
15V COMMON SENSE
TP4
15
C5
.001
R17
4.99K
C6
.001
CR7
IN823
R21
3.48K
R22
500
10% 1/2W
15V ADJ
20T
R18
2.10K
8
U1D
9
10
C8
.01
R26
20.00K
0.1%
R27
20.00K
0.1%
R24
1.182K
0.1%
R28
1.000K
0.1%
C9
68
20V
CR11
IN4148
CR12
IN4383
10
L
9
K
-15V
C7
.001
R20
1.10K
R25
.24
1W, 5%
R23
4.99K
CR8
IN4148
TP5
-15V
11
M
-15V SENSE

ASSEMBLY 16995
REFERENCE DESIGNATORS ARE ABBREVIATED W/PREFIX A2

ITEM	REQD	PART NO.	DESCRIPTION

LIST OF MATERIAL

	LM 324 N
IG	TYPE

FINISH OR TREATMENT

UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES
TOLERANCE
.XX = .015
.XXX = .005
ANGLE : 1/2°
63√.

SCALE

		DATE
DRAWN	M. Le	5-29-84
CHECKED		3-5-87
ENG	N. Kokan	3-5-87
MFG ENG		3-5-87
QA		3-6-87

NEXT ASSY

WAVETEK PACIFIC MEASUREMENTS, INC.
SUNNYVALE, CALIFORNIA

POWER SUPPLY

DRAWING NO. 16996
REV E
SHEET 2 OF 2

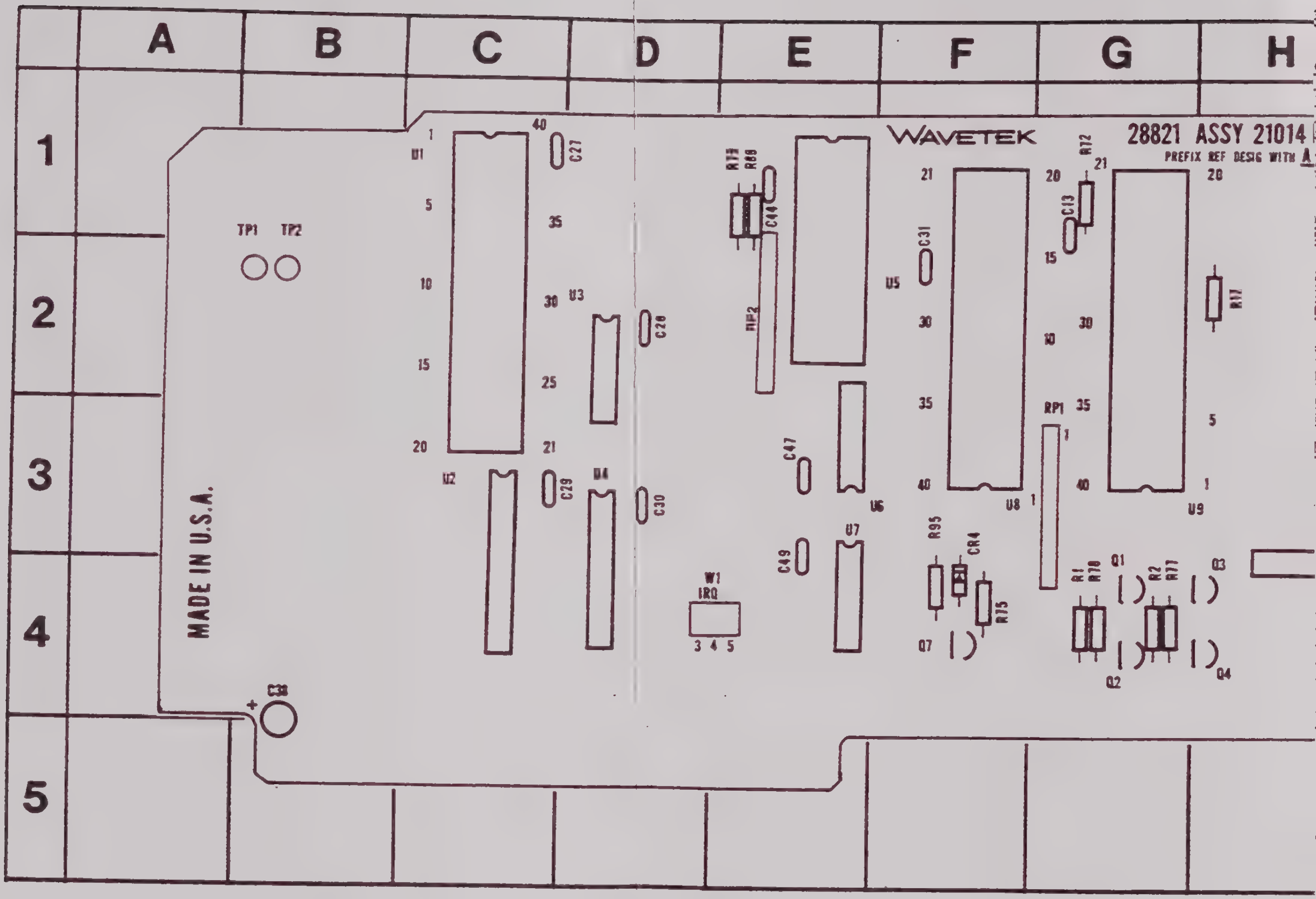
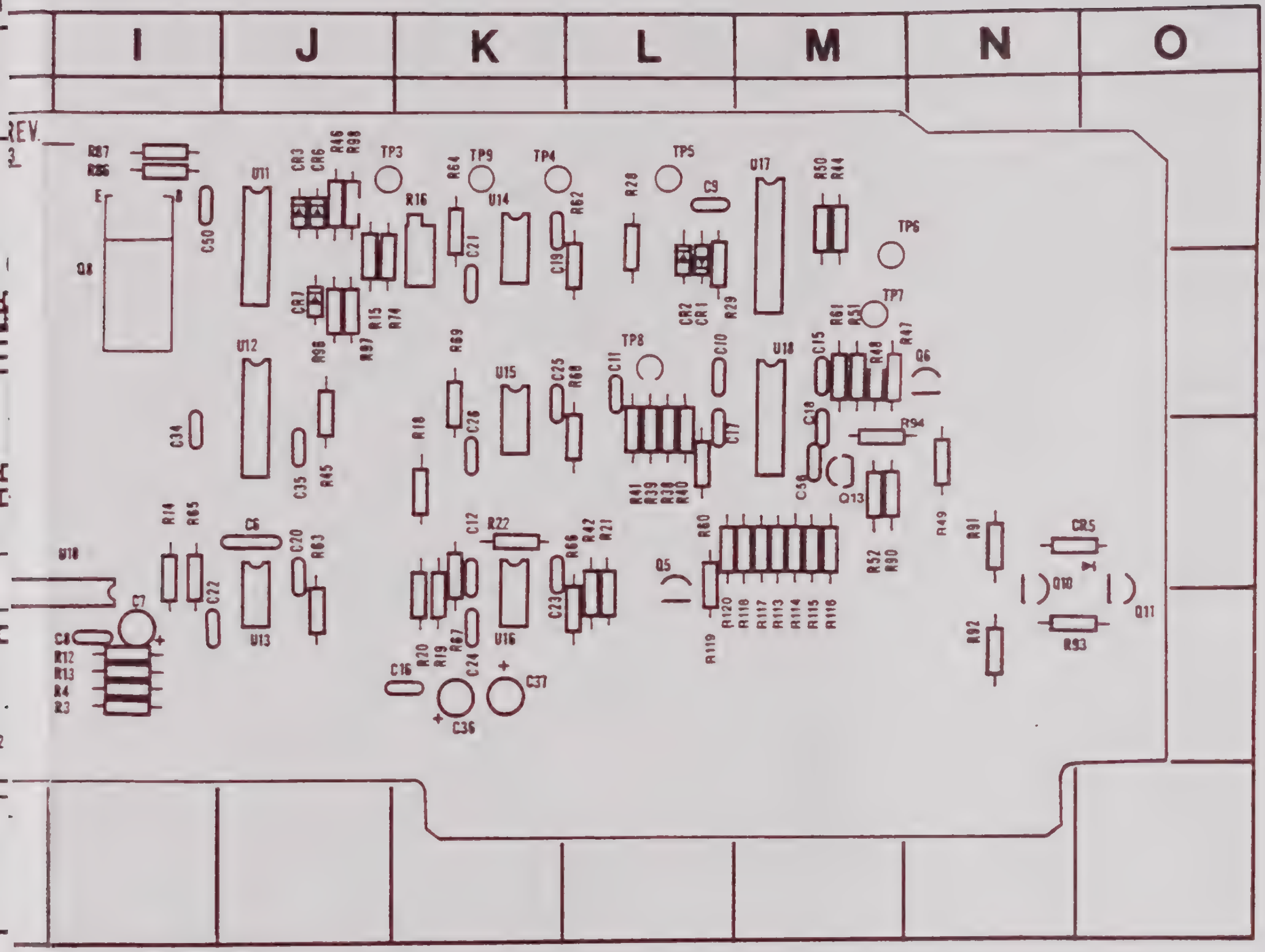

A
B
C
D
E
F
G
H
1
2
3
4
5
WAVETEK
28821 ASSY 21014
PREFIX REF DESIG WITH A
MADE IN U.S.A.
TP1
TP2
U1
U2
U3
U4
U5
U6
U7
U8
U9
C27
C28
C29
C30
C31
C44
C47
C49
C13
C38
R73
R88
R12
R17
R95
R75
R1
R76
R2
R77
RP1
RP2
CR4
Q1
Q2
Q3
Q4
Q7
W1
IRQ
3 4 5

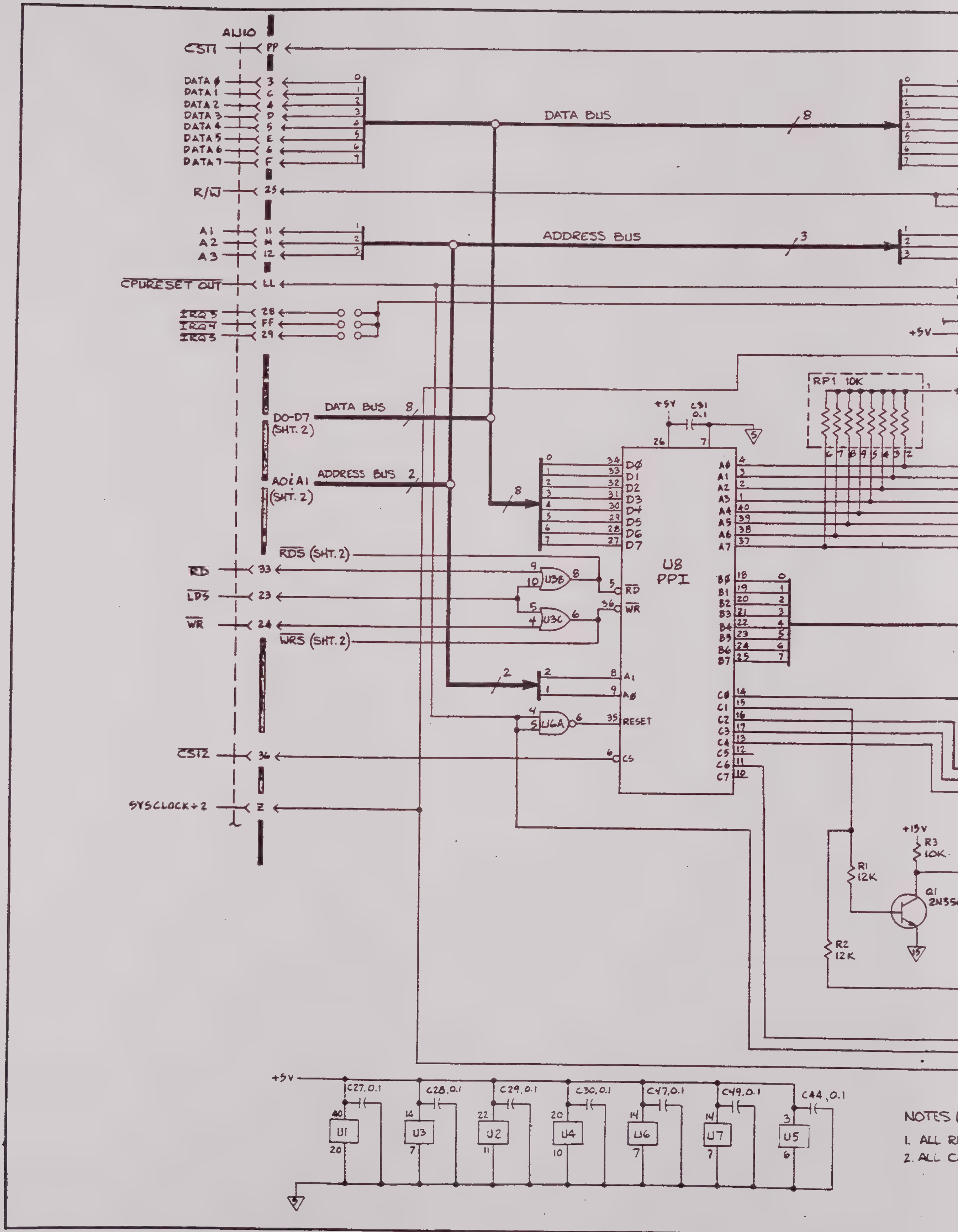
Figure 8-3 GPIB/Cal Control

CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRI LOC
C1		C20	J-3	C39		CR1	L-2	Q12		R16	K-1	R35		R54		R73	
C2		C21	K-2	C40		CR2	L-2	Q13	M-3	R17	H-2	R36		R55		R74	J-2
C3		C22	I-4	C41		CR3	J-1			R18	K-3	R37		R56		R75	F-
C4		C23	K-4	C42		CR4	F-4			R19	K-4	R38	L-3	R57		R76	
C5		C24	K-4	C43		CR5	0-3	R1	G-4	R20	K-4	R39	L-3	R58		R77	G-
C6	J-3	C25	K-2	C44	E-1	CR6	J-1	R2	G-4	R21	L-4	R40	L-3	R59		R78	G-
C7	I-4	C26	K-3	C45		CR7	J-2	R3	I-4	R22	K-3	R41	L-3	R60	L-3	R79	E-
C8	I-4	C27	C-1	C46				R4	I-4	R23		R42	L-4	R61	M-2	R80	
C9	L-1	C28	D-2	C47	E-3	Q1	G-4	R5		R24		R43		R62	L-2	R81	
C10	L-2	C29	C-3	C48		Q2	G-4	R6		R25		R44	M-1	R63	J-4	R82	
C11	L-2	C30	D-3	C49	E-3	Q3	H-4	R7		R26		R45	J-3	R64	K-1	R83	
C12	K-3	C31	F-2	C50	I-1	Q4	H-4	R8		R27		R46	J-1	R65	I-4	R84	
C13	G-1	C32		C51		Q5	L-4	R9		R28	L-2	R47	M-2	R66	L-4	R85	
C14		C33		C52		Q6	N-2	R10		R29	L-2	R48	M-2	R67	K-4	R86	I-1
C15	M-2	C34	I-3	C53		Q7	F-4	R11		R30		R49	N-3	R68	L-3	R87	I-1
C16	K-4	C35	J-3	C54		Q8	I-2	R12	I-4	R31		R50	M-1	R69	K-2	R88	E-
C17	L-3	C36	K-4	C55		Q9		R13	I-4	R32		R51	M-2	R70		R89	
C18	M-3	C37	K-4	C56	M-3	Q10	N-4	R14	I-3	R33		R52	M-3	R71		R90	M
C19	K-2	C38	B-5			Q11	0-4	R15	J-2	R34		R53		R72	G-1	R91	N


I
J
K
L
M
N
O
REV.
3
R87
R86
E
B
Q8
C50
U11
CR3
CR6
R46
R98
TP3
R16
R64
TP9
C21
U14
TP4
R62
C19
R28
TP5
C9
CR2
CR1
R29
U17
R50
R44
TP6
CR7
R15
R74
R97
R96
R61
R51
TP7
R47
Q6
U12
R89
U15
C25
R68
TP8
C11
C10
U18
C15
R48
C34
C35
R45
R18
C26
R41
R39
R38
R40
C17
C18
R94
C58
Q13
R49
U10
R14
R65
C6
C20
R63
C12
R22
R66
R42
R21
Q5
R60
R52
R90
R91
CR5
Q10
Q11
C7
C22
U13
R20
R19
R67
C24
U16
C23
R120
R118
R117
R113
R114
R115
R116
R119
R92
R93
C8
R12
R13
R4
R3
C16
C36
C37

-PCB Assembly #21014

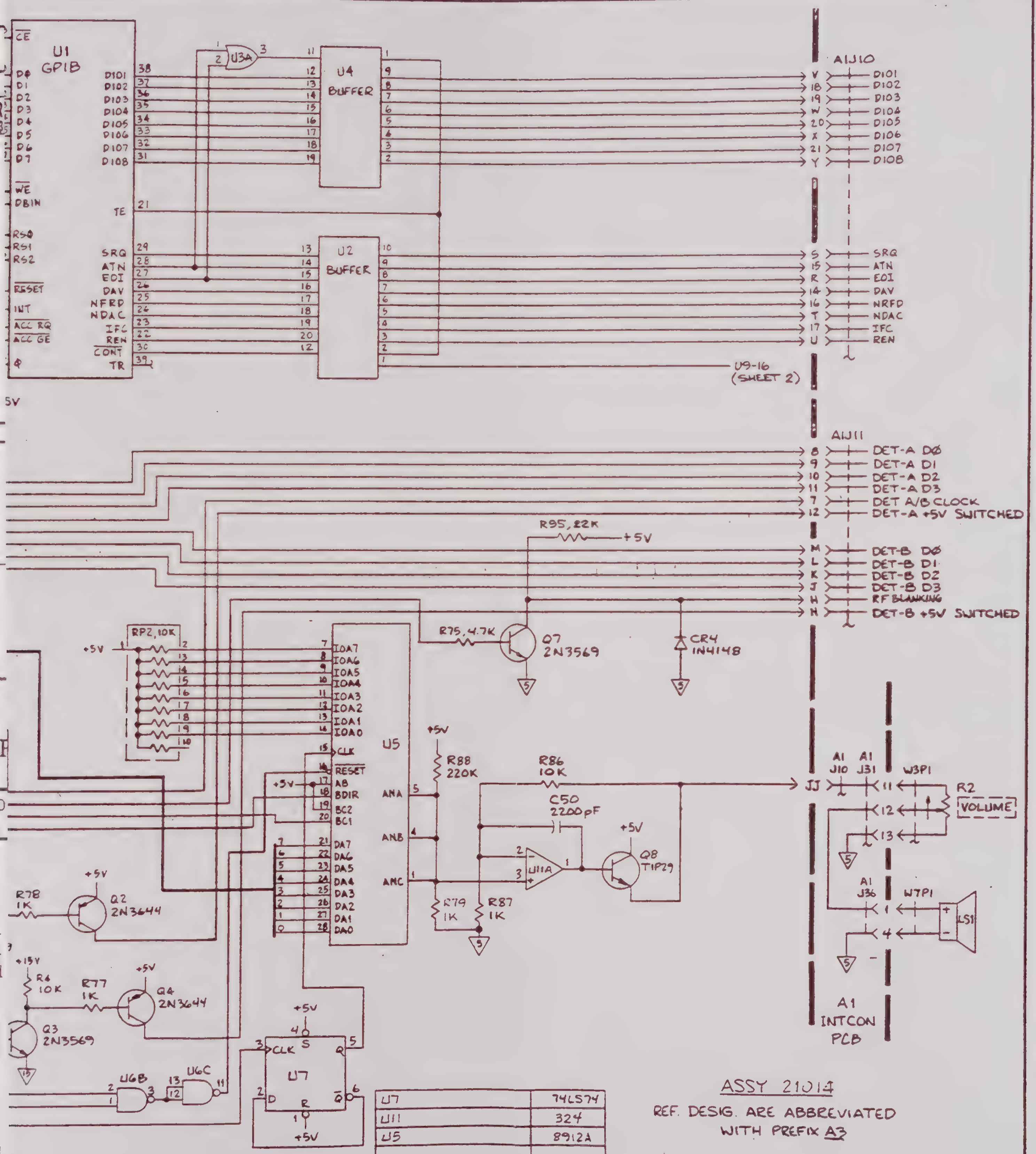
D	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
	R92	N-4	R111	M-3	TP5	L-1	U12	J-2
-	R93	0-4	R112	M-3	TP6	M-2	U13	J-4
	R94	M-3	R113	M-3	TP7	M-2	U14	K-1
	R95	F-4	R114	M-3	TP8	L-2	U15	K-3
4	R96	J-2	R115	M-3	TP9	K-1	U16	K-4
-4	R97	J-2	R116	M-3			U17	M-1
1	R98	J-1	R117	M-3			U18	M-2
	R99		R118	M-3				
	R100		R119		U1	C-1		
	R101		R120		U2	C-3		
	R102				U3	D-2		
	R103		RP1	G-3	U4	D-3		
	R104		RP2	E-2	U5	E-2		
	R105				U6	E-3		
	R106				U7	E-4		
1	R107		TP1	B-2	U8	F-3		
	R108		TP2	B-2	U9	G-3		
-3	R109		TP3	J-1	U10	I-4	W1	E-4
-3	R110		TP4	K-1	U11	J-1		


AIJIO
CSI1
PP
DATA Ø
DATA 1
DATA 2
DATA 3
DATA 4
DATA 5
DATA 6
DATA 7
DATA BUS
8
R/W
25
A1
A2
A3
ADDRESS BUS
3
CPURESET OUT
LL
IRQ 3
IRQ 4
IRQ 5
28
FF
29
+5V
RP1 10K
DO-D7 (SHT. 2)
DATA BUS 8
AO&A1 (SHT. 2)
ADDRESS BUS 2
+5V
C51 0.1
26
7
U8 PPI
34 DØ
33 D1
32 D2
31 D3
30 D4
29 D5
28 D6
27 D7
AØ A1 A2 A3 A4 A5 A6 A7
BØ B1 B2 B3 B4 B5 B6 B7
CØ C1 C2 C3 C4 C5 C6 C7
RDS (SHT. 2)
RD
33
LDS
23
WR
24
WRS (SHT. 2)
U3B
U3C
RD
WR
A1
AØ
U6A
35 RESET
CS
CS12
36
SYSCLOCK÷2
Z
+15V
R3 10K
R1 12K
R2 12K
Q1 2N35
+5V
C27, 0.1
C28, 0.1
C29, 0.1
C30, 0.1
C47, 0.1
C49, 0.1
C44, 0.1
U1
U3
U2
U4
U6
U7
U5
40
20
14
7
22
11
20
10
14
7
14
7
3
6

NOTES (

1. ALL R

2. ALL C


U1
GPIB
CE
D0
D1
D2
D3
D4
D5
D6
D7
WE
DBIN
RS0
RS1
RS2
RESET
INT
ACC RQ
ACC GE
Φ
DIO1
DIO2
DIO3
DIO4
DIO5
DIO6
DIO7
DIO8
TE
SRQ
ATN
EOI
DAV
NFRD
NDAC
IFC
REN
CONT
TR
U3A
U4
BUFFER
U2
BUFFER
U9-16
(SHEET 2)
A1J10
A1J11
DET-A D0
DET-A D1
DET-A D2
DET-A D3
DET A/B CLOCK
DET-A +5V SWITCHED
DET-B D0
DET-B D1
DET-B D2
DET-B D3
RF BLANKING
DET-B +5V SWITCHED
R95, 22K
+5V
RP2, 10K
R75, 4.7K
Q7
2N3569
CR4
IN4148
U5
IOA7
IOA6
IOA5
IOA4
IOA3
IOA2
IOA1
IOA0
CLK
RESET
AB
BDIR
BC2
BC1
DA7
DA6
DA5
DA4
DA3
DA2
DA1
DA0
ANA
ANB
ANC
R88
220K
R86
10K
C50
2200pF
U11A
Q8
TIP29
R79
1K
R87
1K
A1 J10
A1 J31
W3P1
R2
VOLUME
A1 J36
W7P1
LS1
A1
INTCON
PCB
R78
1K
Q2
2N3644
+15V
R4
10K
R77
1K
Q4
2N3644
Q3
2N3569
U6B
U6C
U7
CLK
S
Q
D
R
Q̄

ASSY 21014

REF. DESIG. ARE ABBREVIATED WITH PREFIX A3

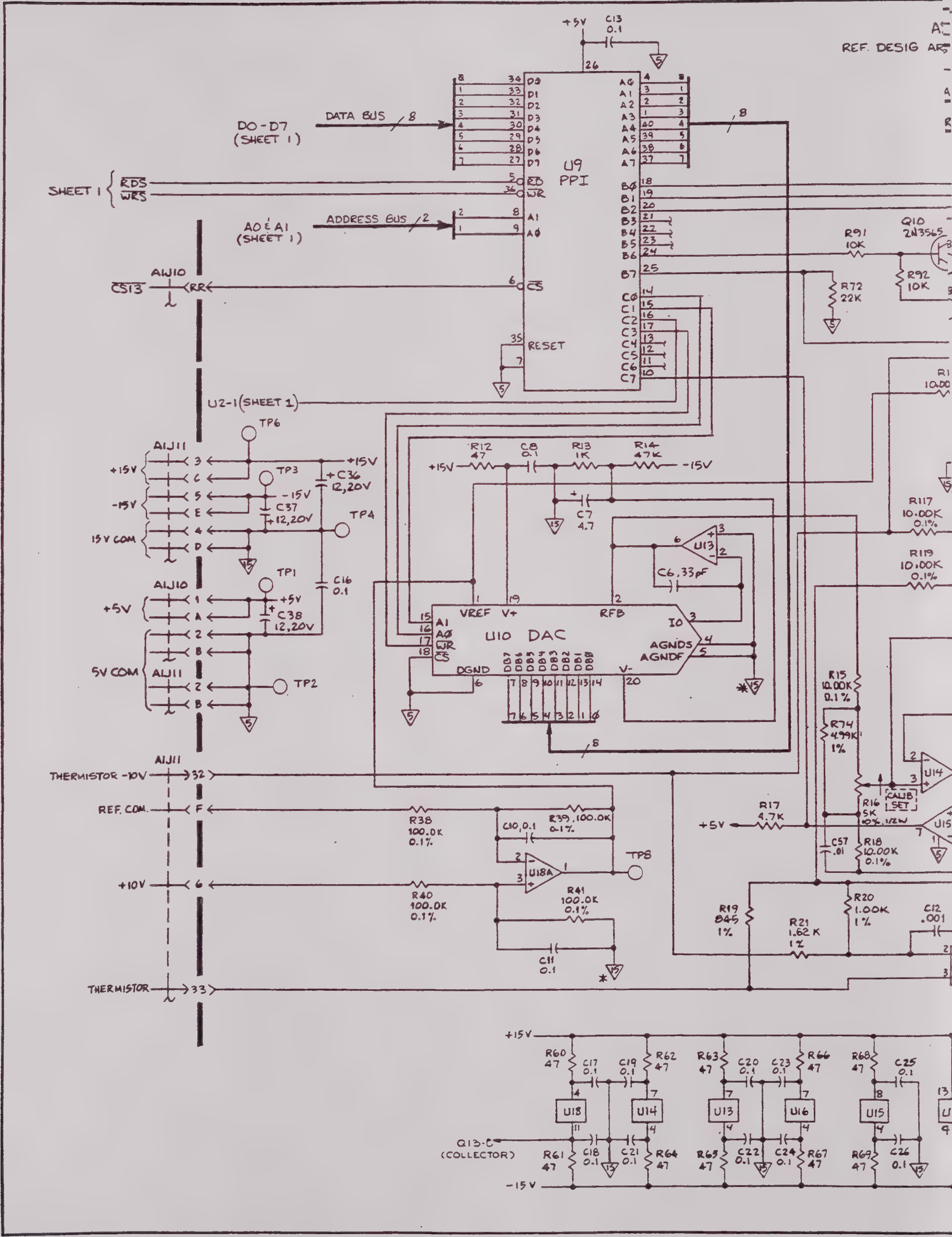
INLESS OTHERWISE SPECIFIED):

SISTOR VALUES ARE IN OHMS, ±5%, 1/4W.

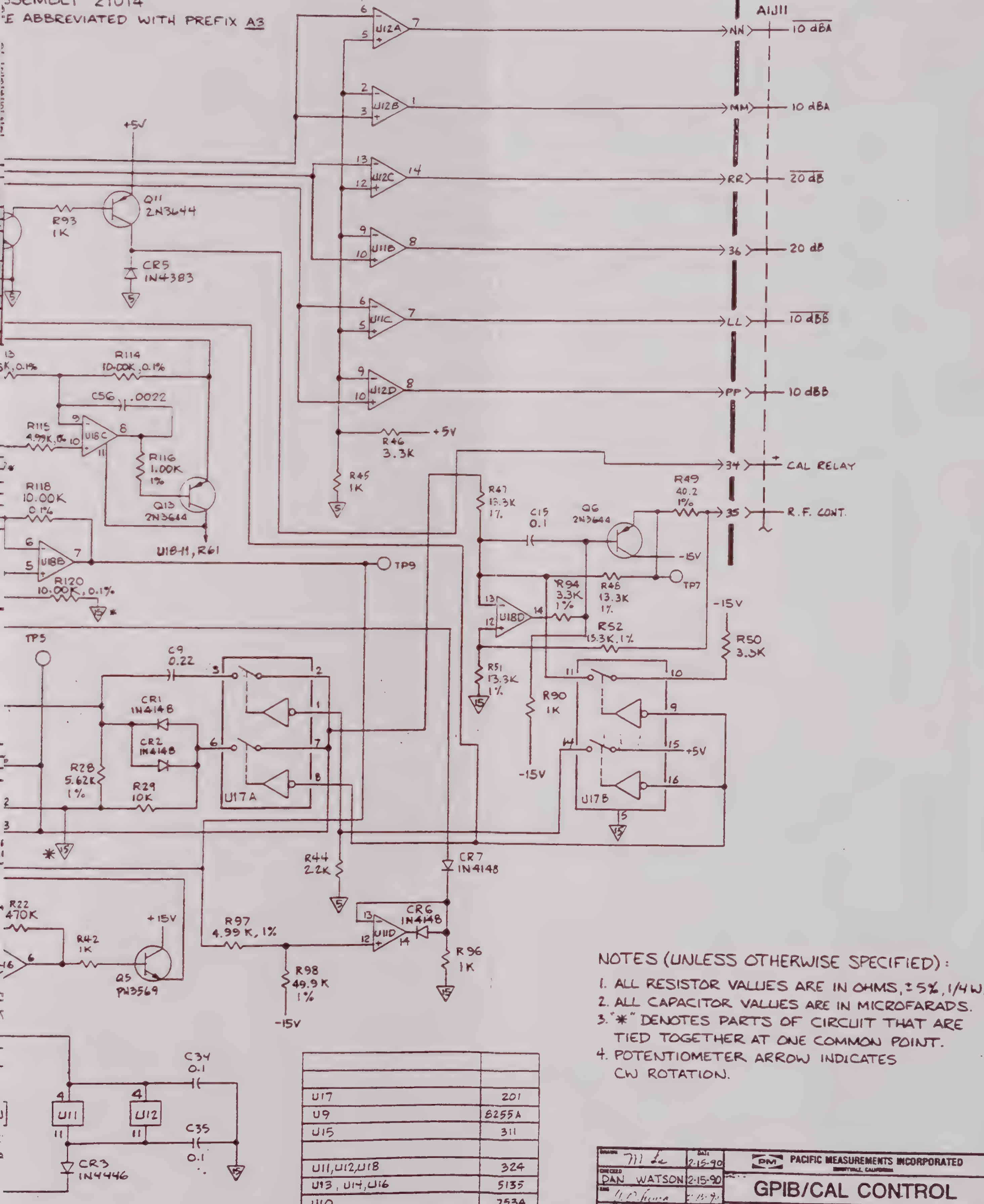
PACITOR VALUES ARE IN MICROFARADS.

REF. DESIG.	TYPE
U7	74LS74
U11	324
U5	8912A
U6	74LS00
U8	8255A
U4	75160
U3	74LS32
U2	75162
U1	9914A

DRAWN 7/11 Le	DATE 2-15-90	PM PACIFIC MEASUREMENTS INCORPORATED SUNNYVALE CALIFORNIA
CHECKED DAN WATSON	2-15-90	GPIB/CAL CONTROL
ENG	2-15-90	DRAWING NO. 21015 REV C
	2-16-90	SHEET 1 OF 2


REF. DESIG
+5V
C13 0.1
26
DATA BUS 8
D0-D7 (SHEET 1)
D0 D1 D2 D3 D4 D5 D6 D7
U9 PPI
A0 A1 A2 A3 A4 A5 A6 A7
B0 B1 B2 B3 B4 B5 B6 B7
C0 C1 C2 C3 C4 C5 C6 C7
SHEET 1
RDS
WRS
RD
WR
ADDRESS BUS 2
A0 & A1 (SHEET 1)
A1
A0
A1J10
CS13
RR
CS
RESET
U2-1 (SHEET 1)
R91 10K
Q10 2N3565
R92 10K
R72 22K
TP6
A1J11
+15V
-15V
15V COM
TP3
+C36 12,20V
C37 12,20V
TP4
TP1
C16 0.1
A1J10
+5V
C38 12,20V
5V COM
A1J11
TP2
R12 47
C8 0.1
R13 1K
R14 47K
C7 4.7
U13
C6, 33pF
VREF
V+
RFB
U10 DAC
IO
AGNDS
AGNDF
DGND
V-
WR
R1 10.00
R117 10.00K 0.1%
R119 10.00K 0.1%
R15 10.00K 0.1%
R74 4.99K 1%
U14
R16 5K 10% 1/2W
CALIB SET
U15
R17 4.7K
C57 .01
R18 10.00K 0.1%
THERMISTOR -10V
REF. COM.
R38 100.0K 0.1%
C10, 0.1
R39, 100.0K 0.1%
U18A
TP8
+10V
R40 100.0K 0.1%
R41 100.0K 0.1%
C11 0.1
THERMISTOR
R19 845 1%
R21 1.62 K 1%
R20 1.00K 1%
C12 .001
R60 47
C17 0.1
C19 0.1
R62 47
R63 47
C20 0.1
C23 0.1
R66 47
R68 47
C25 0.1
U18
U14
U13
U16
U15
Q13-C (COLLECTOR)
R61 47
C18 0.1
C21 0.1
R64 47
R65 47
C22 0.1
C24 0.1
R67 47
R69 47
C26 0.1

SSEMBLY 21014
E ABBREVIATED WITH PREFIX A3



+5V
R93
1K
Q11
2N3644
CR5
1N4383
U12A
U12B
U12C
U11B
U11C
U12D
AIJ11
NN
10 dBA
MM
10 dBA
RR
20 dB
36
20 dB
LL
10 dBB
PP
10 dBB
34
CAL RELAY
35
R.F. CONT.
R46
3.3K
+5V
R45
1K
R47
13.3K
1%
C15
0.1
Q6
2N3644
R49
40.2
1%
-15V
TP7
R94
3.3K
1%
R48
13.3K
1%
R52
13.3K, 1%
U18D
R51
13.3K
1%
R50
3.3K
-15V
R90
1K
-15V
U17B
+5V
R114
10.00K, 0.1%
C56
.0022
R115
4.99K, 0.1%
U18C
R116
1.00K
1%
Q13
2N3644
U18-11, R61
R118
10.00K
0.1%
U18B
TP9
R120
10.00K, 0.1%
TP5
C9
0.22
CR1
1N4148
CR2
1N4148
R28
5.62K
1%
R29
10K
U17A
R44
2.2K
CR7
1N4148
CR6
1N4148
U11D
R96
1K
R97
4.99 K, 1%
R98
49.9 K
1%
-15V
R22
470K
+15V
R42
1K
Q5
PN3569
U11
U12
C34
0.1
C35
0.1
CR3
1N4446

NOTES (UNLESS OTHERWISE SPECIFIED):

1. ALL RESISTOR VALUES ARE IN OHMS, ±5%, 1/4 W.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.
3. "✱" DENOTES PARTS OF CIRCUIT THAT ARE TIED TOGETHER AT ONE COMMON POINT.
4. POTENTIOMETER ARROW INDICATES CW ROTATION.

REF. DESIG.	TYPE
U17	201
U9	8255A
U15	311
U11, U12, U18	324
U13, U14, U16	5135
U10	7534

Ml Le	2-15-90	PACIFIC MEASUREMENTS INCORPORATED SUNNYVALE, CALIFORNIA
DAN WATSON	2-15-90	GPIB/CAL CONTROL
	2-15-90	21015 C
H Kelm	2-16-90	SHEET 2 OF 2

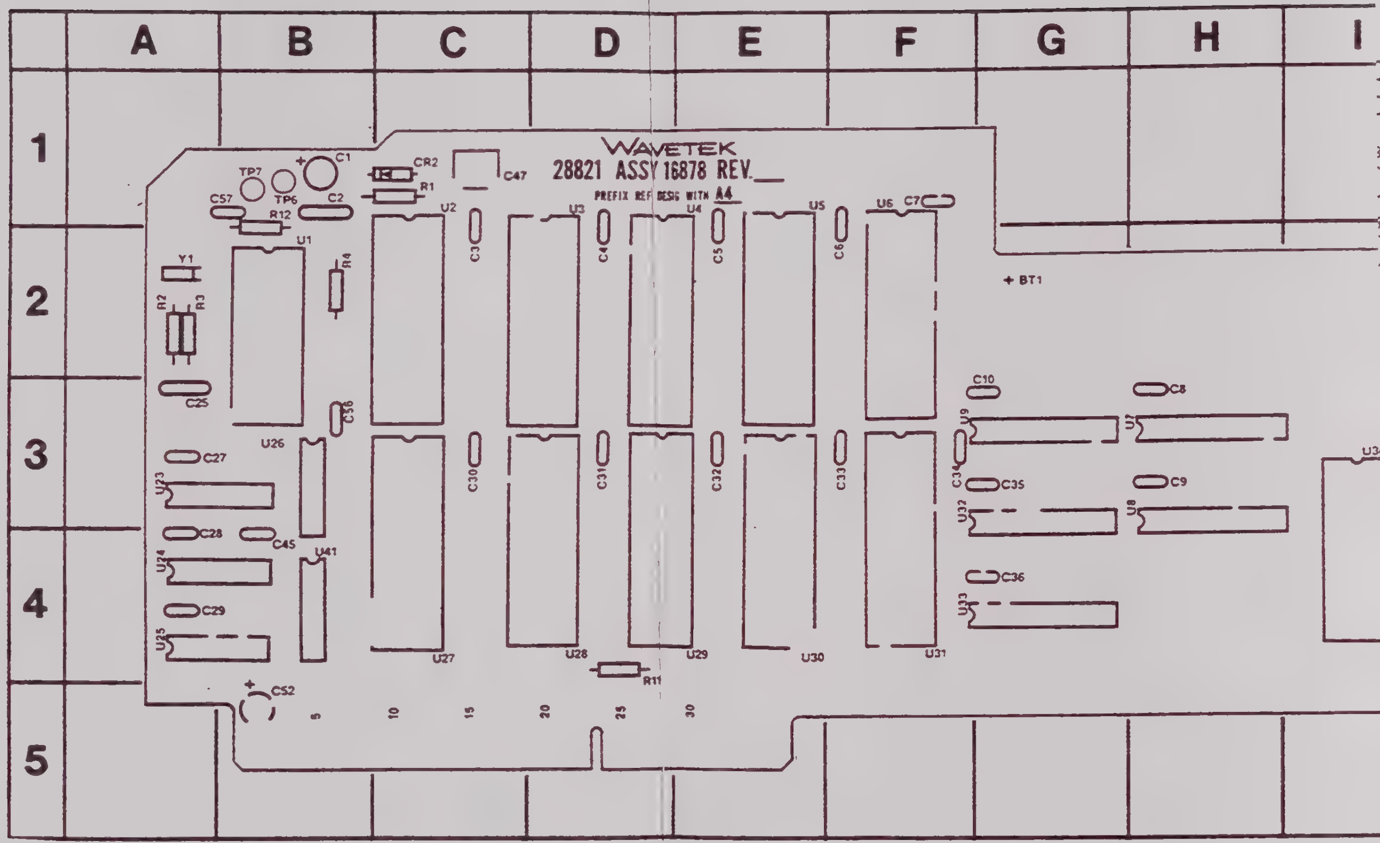
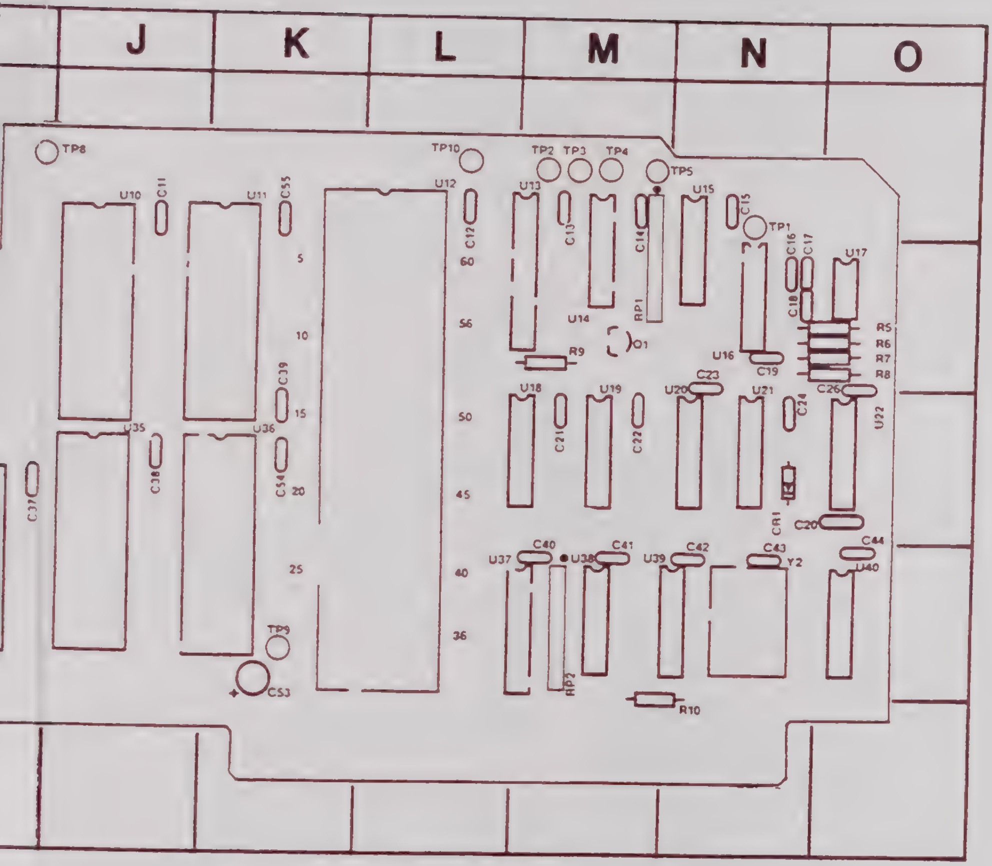

A
B
C
D
E
F
G
H
I
1
2
3
4
5
WAVETEK
28821 ASSY 16878 REV.__
PREFIX REF DESIG WITH A4
C1
CR2
R1
C47
TP7
TP6
C2
C57
R12
U1
U2
U3
U4
U5
U6
C7
C3
C4
C5
C6
Y1
R2
R3
R4
+ BT1
C10
C8
C25
C36
U9
U7
U26
C27
C30
C31
C32
C33
C34
C35
C9
U23
U32
U8
C28
C45
U41
U24
C36
C29
U33
U25
U27
U28
U29
U30
U31
R11
C52
5
10
15
20
25
30

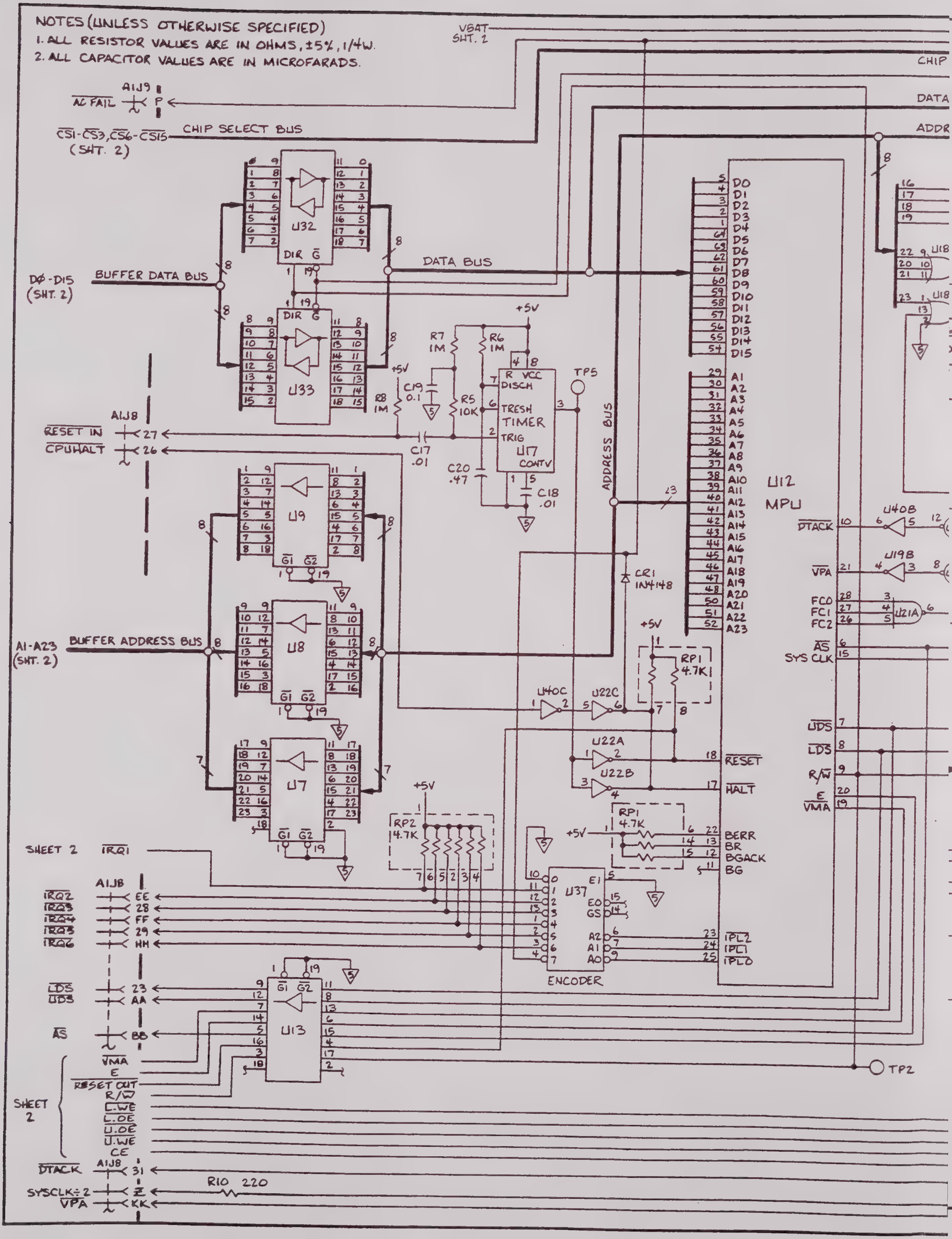
Figure 8-4 CPU PCB Assembly #

CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
C1	B-1	C20	0-3	C39	K-3	CR-1	N-3	R11	D-4	U1	B-2	U20	N-3	U39	M-4
C2	B-1	C21	M-3	C40	M-4	CR2	C-1	R12	B-1	U2	B-2	U21	N-3	U40	0-4
C3	C-2	C22	M-3	C41	M-4	BT1	H-1			U3	C-2	U22	O-3	U41	B-4
C4	D-2	C23	N-3	C42	N-4			RP1	M-2	U4	D-2	U23	A-3		
C5	E-2	C24	N-3	C43	N-4			RP2	M-4	U5	E-2	U24	A-4		
C6	F-2	C25	A-3	C44	0-4					U6	F-2	U25	A-4	Y1	A-2
C7	F-1	C26	0-2	C45	B-4	Q1	M-2	TP1	N-1	U7	H-3	U26	B-3	Y2	N-4
C8	H-3	C27	A-3	C46				TP2	M-1	U8	H-3	U27	C-4		
C9	H-3	C28	A-4	C47	C-1			TP3	M-1	U9	G-3	U28	C-4		
C10	G-3	C29	A-4	C48		R1	C-1	TP4	M-1	U10	J-2	U29	D-4		
C11	J-2	C30	C-3	C49		R2	A-2	TP5	M-1	U11	K-2	U30	E-4		
C12	L-1	C31	D-3	C50		R3	A-2	TP6	B-1	U12	K-1	U31	F-4		
C13	M-1	C32	E-3	C51		R4	B-2	TP7	B-1	U13	L-2	U32	G-3		
C14	M-1	C33	F-3	C52	B-5	R5	0-2	TP8	I-1	U14	M-2	U33	G-4		
C15	N-1	C34	G-3	C53	K-4	R6	0-2	TP9	K-4	U15	N-2	U34	I-3		
C16	N-2	C35	G-3	C54	K-3	R7	0-2	TP10	L-1	U16	N-2	U35	I-3		
C17	N-2	C36	G-4	C55	K-2	R8	0-2			U17	0-2	U36	J-4		
C18	N-2	C37	I-3	C56	B-3	R9	M-2			U18	L-3	U37	L-4		
C19	N-2	C38	J-3	C57	B-1	R10	M-4			U19	M-3	U38	M-4		

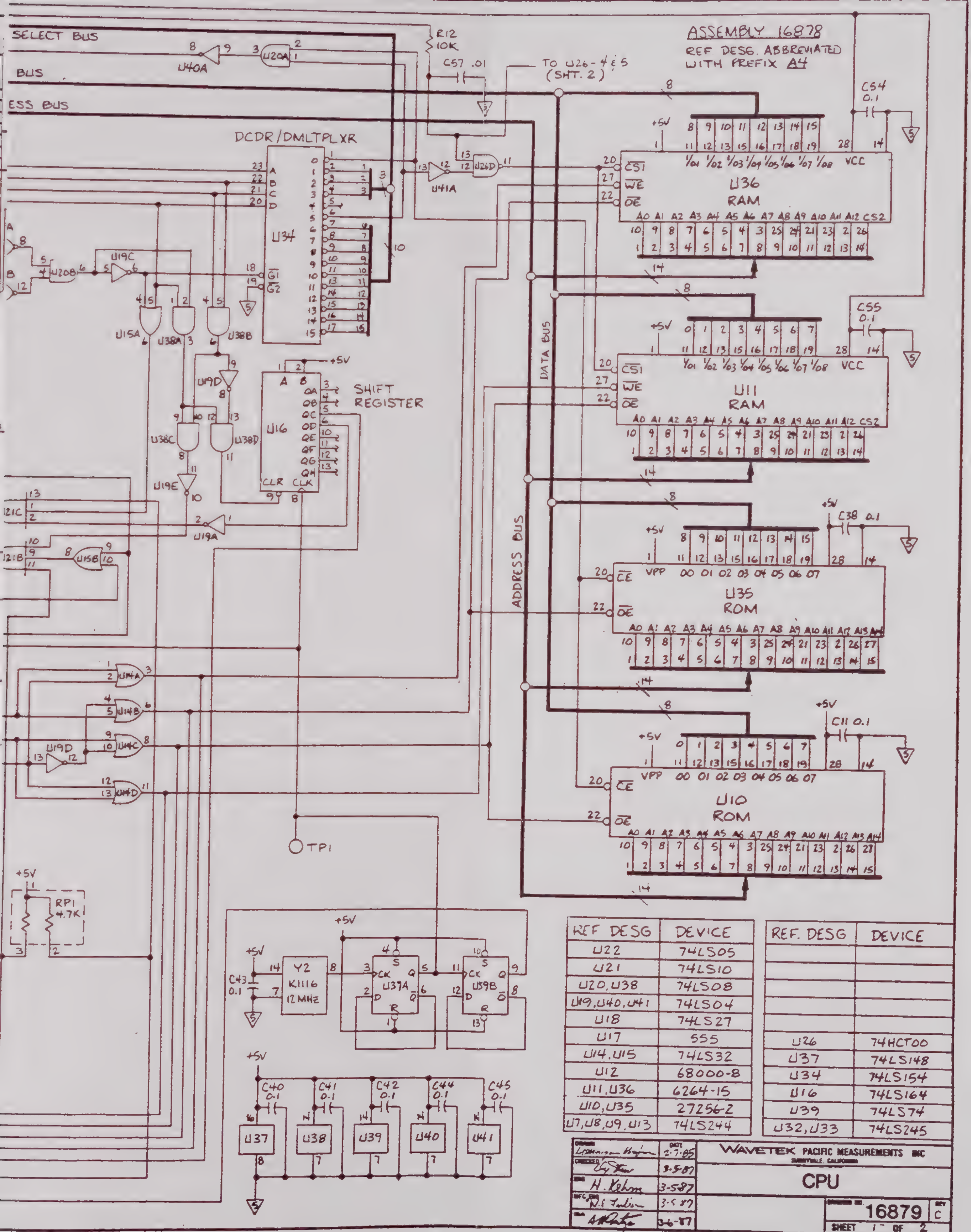

J
K
L
M
N
O
TP8
TP10
TP2
TP3
TP4
TP5
TP1
TP9
U10
U11
U12
U13
U14
U15
U16
U17
U18
U19
U20
U21
U22
U35
U36
U37
U38
U39
U40
C11
C55
C12
C13
C14
C15
C16
C17
C18
C19
C20
C21
C22
C23
C24
C26
C37
C38
C39
C40
C41
C42
C43
C44
C53
C54
RP1
RP2
R5
R6
R7
R8
R9
R10
Q1
CR1
Y2
5
10
15
20
25
60
56
50
45
40
36

6878

NOTES (UNLESS OTHERWISE SPECIFIED)
1. ALL RESISTOR VALUES ARE IN OHMS, ±5%, 1/4W.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.



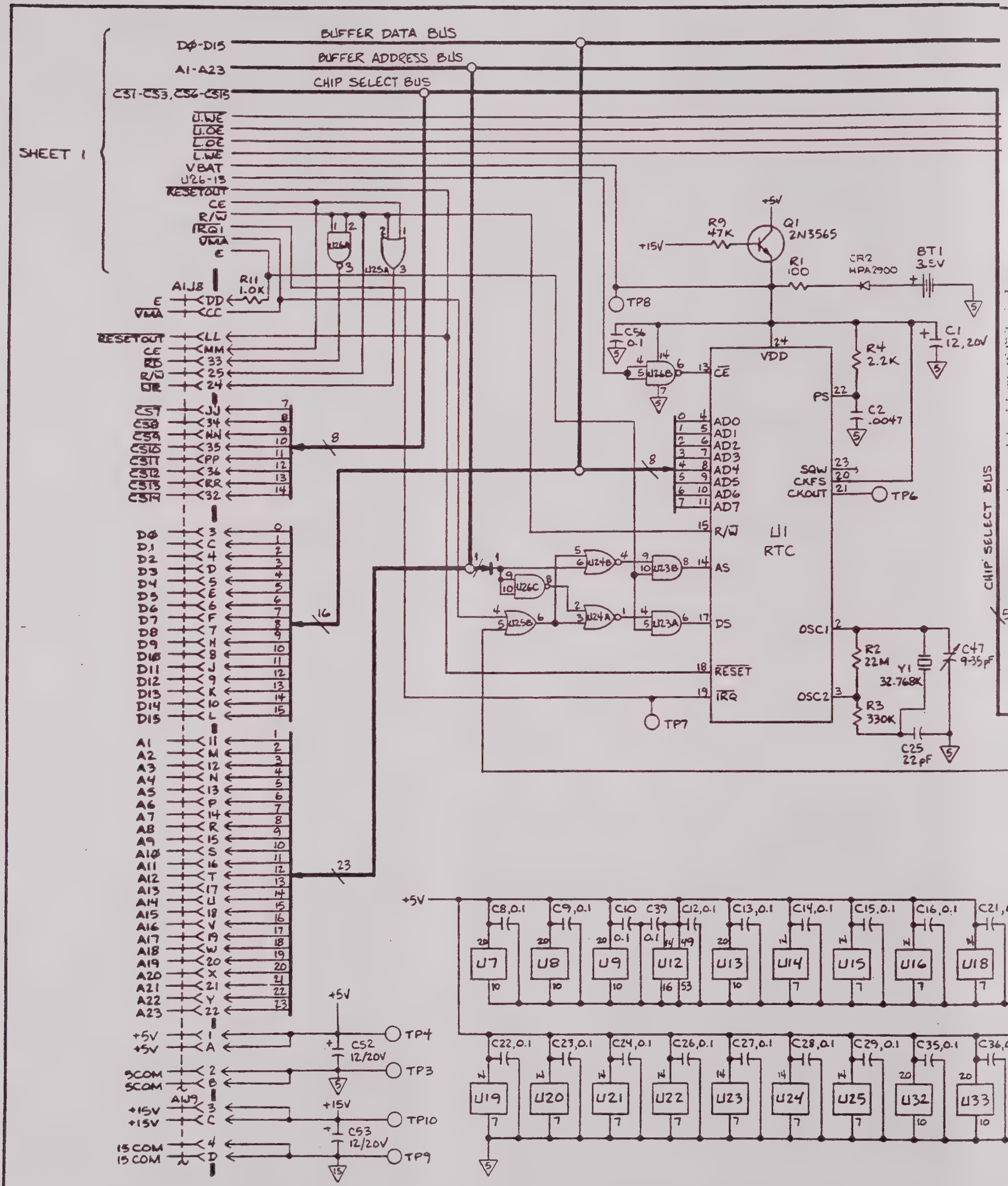
VBAT SHT. 2
CHIP
DATA
ADDR
A1J9
AC FAIL
P
CS1-CS3, CS6-CS15 (SHT. 2)
CHIP SELECT BUS
D0-D15 (SHT. 2)
BUFFER DATA BUS
DATA BUS
U32
U33
DIR
G
+5V
R7 1M
R6 1M
R8 1M
R5 10K
C19 0.1
C17 .01
C20 .47
C18 .01
R VCC
DISCH
TRESH
TIMER
TRIG
U17
CONTV
TP5
A1J8
RESET IN
CPUHALT
ADDRESS BUS
U9
U8
U7
G1 G2
A1-A23 (SHT. 2)
BUFFER ADDRESS BUS
CR1 1N4148
U12 MPU
D0 D1 D2 D3 D4 D5 D6 D7 D8 D9 D10 D11 D12 D13 D14 D15
A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15 A16 A17 A18 A19 A20 A21 A22 A23
DTACK
VPA
FC0 FC1 FC2
AS
SYS CLK
UDS
LDS
R/W
E
VMA
RESET
HALT
BERR
BR
BGACK
BG
IPL2 IPL1 IPL0
U40B
U19B
U21A
U40C
U22C
U22A
U22B
RP1 4.7K
RP2 4.7K
U37
ENCODER
E1 E0 GS
A2 A1 A0
U18
SHEET 2 IRQ1
IRQ2 IRQ3 IRQ4 IRQ5 IRQ6
EE 28 FF 29 HH
LDS UDS
23 AA
AS BB
U13
VMA
E
RESET OUT
R/W
L.WE
L.OE
U.OE
U.WE
CE
SHEET 2
DTACK 31
SYSCLK÷2 Z
VPA KK
R10 220
TP2


ASSEMBLY 16878
REF. DESG. ABBREVIATED WITH PREFIX A4
SELECT BUS
BUS
ESS BUS
U40A
U20A
R12 10K
C57 .01
TO U26-4 & 5 (SHT. 2)
C54 0.1
DCDR/DMLTPLXR
U34
U41A
U26D
U36 RAM
CS1
WE
OE
VCC
CS2
U19C
U20B
U15A
U38A
U38B
U19D
U38C
U38D
U19E
U16
SHIFT REGISTER
CLR
CLK
U19A
U21C
U21B
U15B
DATA BUS
ADDRESS BUS
C55 0.1
U11 RAM
C38 0.1
U35 ROM
CE
VPP
U14A
U14B
U14C
U14D
U19D
C11 0.1
U10 ROM
TP1
+5V
RP1 4.7K
C43 0.1
Y2 K1116 12MHz
U39A
U39B
C40 0.1
C41 0.1
C42 0.1
C44 0.1
C45 0.1
U37
U38
U39
U40
U41

REF DESG	DEVICE
U22	74LS05
U21	74LS10
U20, U38	74LS08
U19, U40, U41	74LS04
U18	74LS27
U17	555
U14, U15	74LS32
U12	68000-8
U11, U36	6264-15
U10, U35	27256-2
U7, U8, U9, U13	74LS244

REF. DESG	DEVICE
U26	74HCT00
U37	74LS148
U34	74LS154
U16	74LS164
U39	74LS74
U32, U33	74LS245

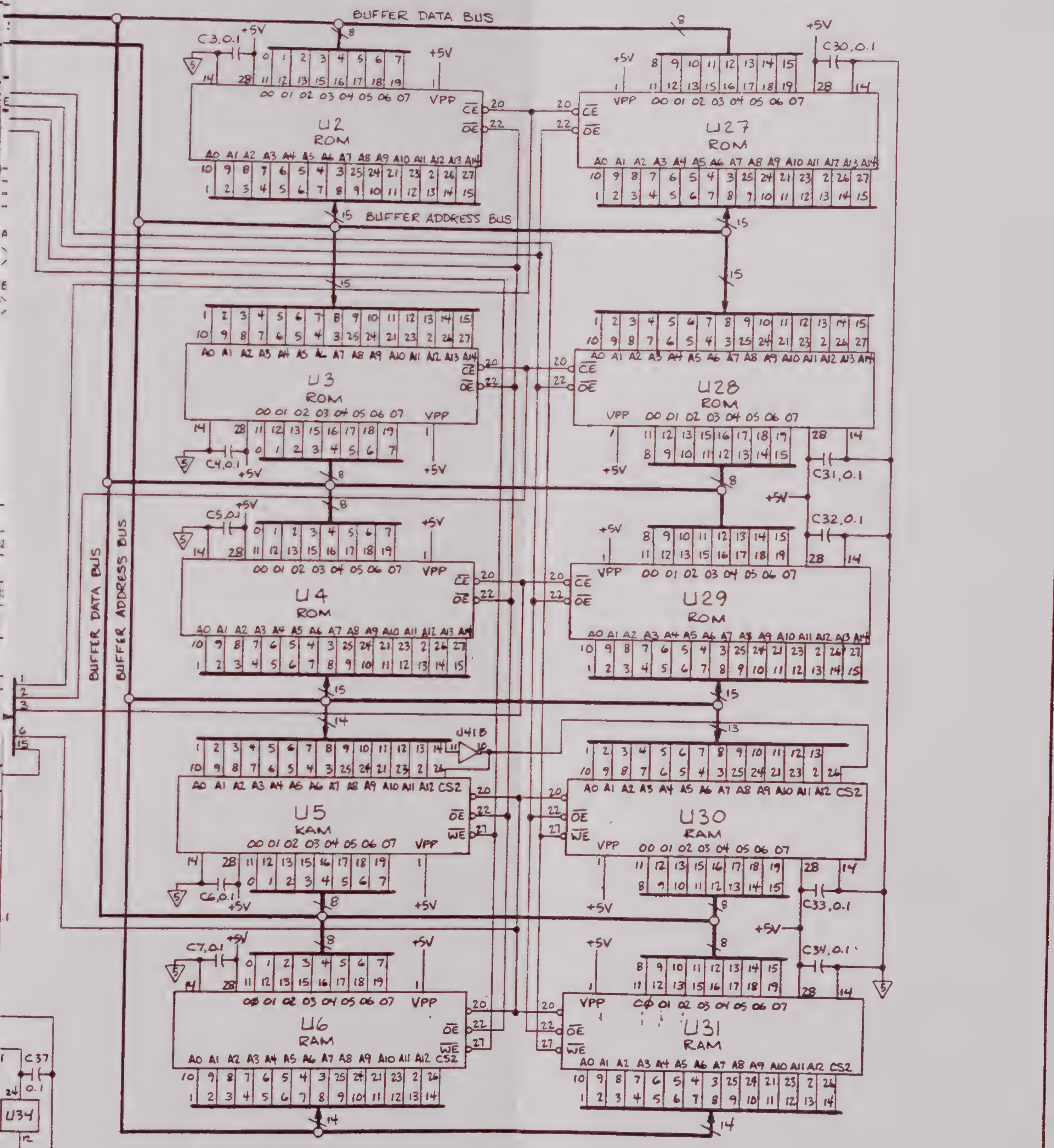
	DATE	WAVETEK PACIFIC MEASUREMENTS INC SUNNYVALE, CALIFORNIA
DRAWN	2-7-85	CPU
CHECKED	3-5-87	
ENG H. Kehm	3-5-87	DRAWING NO. 16879 REV C
MFG. ENG	3-5-87	SHEET 1 OF 2
	3-6-87	


BUFFER DATA BUS
BUFFER ADDRESS BUS
CHIP SELECT BUS
D0-D15
A1-A23
CS1-CS3, CS6-CS15
SHEET 1
U.WE
U.OE
L.OE
L.WE
VBAT
U26-13
RESETOUT
CE
R/W
IRQ1
VMA
E
A1J8
R11 1.0K
U26A
U25A
+5V
+15V
R9 47K
Q1 2N3565
R1 100
CR2 HPA2900
BT1 3.5V
C1 12,20V
TP8
C56 0.1
U26B
R4 2.2K
C2 .0047
VDD
CE
PS
AD0
AD1
AD2
AD3
AD4
AD5
AD6
AD7
SQW
CKFS
CKOUT
TP6
R/W
U1 RTC
AS
DS
OSC1
OSC2
RESET
IRQ
U24B
U23B
U26C
U25B
U24A
U23A
R2 22M
Y1 32.768K
C47 9-35pF
R3 330K
C25 22pF
TP7
CHIP SELECT BUS
C8,0.1
C9,0.1
C10 0.1
C39 0.1
C12,0.1
C13,0.1
C14,0.1
C15,0.1
C16,0.1
C21
U7
U8
U9
U12
U13
U14
U15
U16
U18
C22,0.1
C23,0.1
C24,0.1
C26,0.1
C27,0.1
C28,0.1
C29,0.1
C35,0.1
C36
U19
U20
U21
U22
U23
U24
U25
U32
U33
C52 12/20V
TP4
TP3
C53 12/20V
TP10
TP9
A1J9
5COM
15COM

NOTES (UNLESS OTHERWISE SPECIFIED):
1. ALL RESISTOR VALUES ARE IN OHMS, ±5%, 1/4W.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.

ASSEMBLY 16878

REF DESG. ABBREVIATED WITH PREFIX A4


BUFFER DATA BUS
BUFFER ADDRESS BUS
U2 ROM
U27 ROM
U3 ROM
U28 ROM
U4 ROM
U29 ROM
U5 RAM
U30 RAM
U6 RAM
U31 RAM
U41B
U34
C3,0.1
C30,0.1
C4,0.1
C31,0.1
C5,0.1
C32,0.1
C6,0.1
C33,0.1
C7,0.1
C34,0.1
C37 0.1
+5V
VPP
CE
OE
WE
CS2

REF. DESG	DEVICE
U41	74LS04
U1	146818
U2, U3, U4, U27, U28, U29	27256-2
U5, U6, U31, U30	6264-15
U23	74LS08
U24	74LS02
U25	74LS32
U26	74HCT00

R. PETTERSSON	11-7-84	PACIFIC MEASUREMENTS INCORPORATED SUNNYVALE, CALIFORNIA
	3-5-87	CPU
H. Kol	3-5-87	
WS	3-5-87	16879 C
	3-6-87	SHEET 2 OF 2

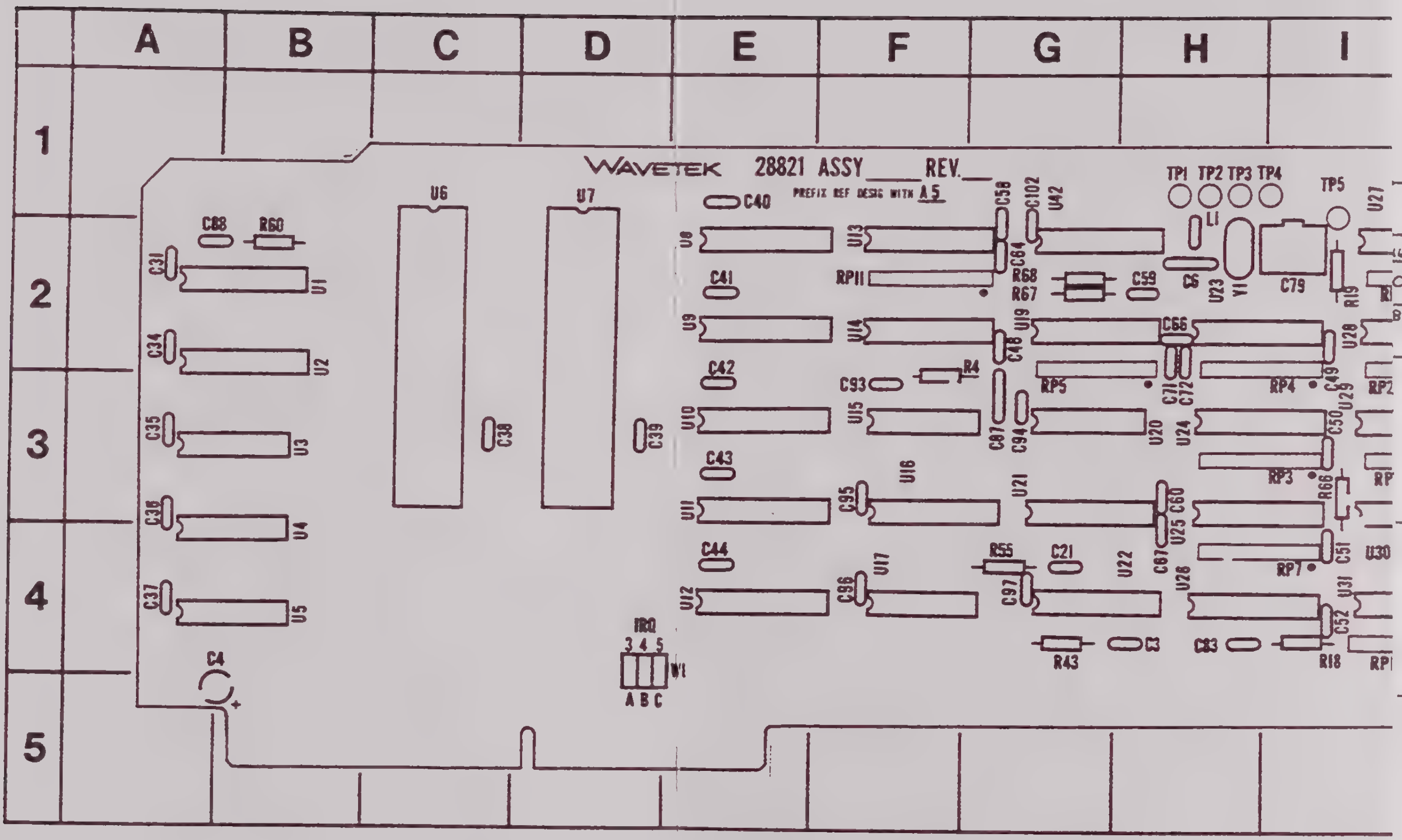
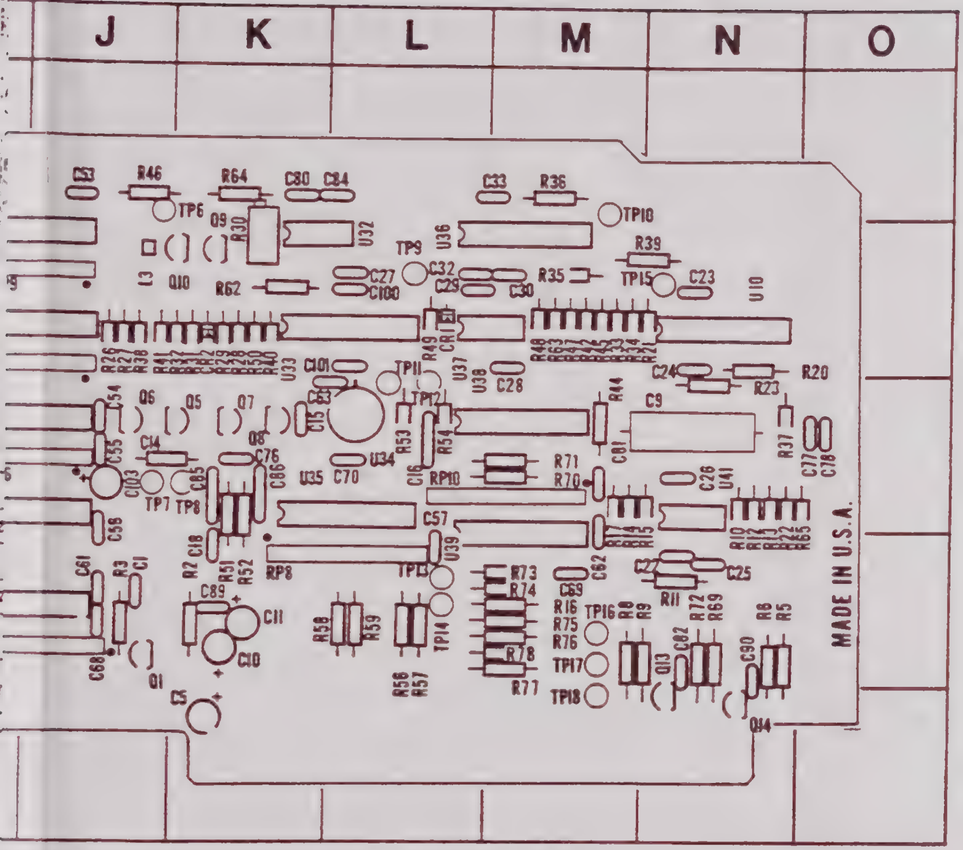

A
B
C
D
E
F
G
H
I
1
2
3
4
5
WAVETEK
28821 ASSY____REV.__
PREFIX REF DESIG WITH A5
TP1 TP2 TP3 TP4
TP5
U6
U7
C88
R60
C31
U1
C34
U2
C35
U3
C36
U4
C37
U5
C4
C38
C39
C40
C41
C42
C43
C44
U8
U9
U10
U11
U12
U13
U14
U15
U16
U17
RP11
R68
R67
C59
C58
C64
C102
U42
L1
C6
U23
Y1
C79
R19
U27
U19
C48
C66
U28
C93
R4
RP5
C71
C72
RP4
C49
U29
RP2
C87
C94
U20
U24
C50
RP3
R66
C95
U21
C60
U25
R55
C21
U22
C67
C51
RP7
U30
C96
C97
U26
U31
C52
R43
C3
C83
R18
RP1
IRQ
3 4 5
W1
A B C

Figure 8-5 Digital Delay PCB Assembly

CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
C1	J-4	C20		C39	D-3	C58	G-1	C77	O-3	C96	F-4	Q3		R6	N-4
C2		C21	G-4	C40	E-1	C59	H-2	C78	O-3	C97	G-4	Q4		R7	
C3	H-4	C22	N-4	C41	E-2	C60	H-3	C79	I-2	C98		Q5	K-3	R8	M-4
C4	B-4	C23	N-2	C42	E-2	C61	J-4	C80	K-1	C99		Q6	J-3	R9	N-4
C5	K-5	C24	N-2	C43	E-2	C62	M-3	C81	M-3	C100	L-2	Q7	K-3	R10	N-3
C6	H-2	C25	N-4	C44	E-4	C63	L-3	C82	N-4	C101	L-2	Q8	K-3	R11	N-4
C7		C26	N-3	C45		C64	G-2	C83	H-4	C102	G-1	Q9	K-2	R12	N-3
C8		C27	L-2	C46		C65		C84	L-1	C103	J-3	Q10	K-2	R13	N-3
C9	N-3	C28	M-2	C47		C66	H-2	C85	K-3			Q11		R14	M-3
C10	K-4	C29	L-2	C48	G-2	C67	H-4	C86	K-3			Q12		R15	N-3
C11	K-4	C30	M-2	C49	I-2	C68	J-4	C87	G-3	CR1	L-2	Q13	N-4	R16	M-4
C12		C31	A-2	C50	I-3	C69	M-4	C88	B-2	CR2	K-2	Q14	N-5	R17	M-3
C13		C32	L-2	C51	I-4	C70	L-3	C89	K-4					R18	I-4
C14	J-3	C33	M-1	C52	I-4	C71	H-2	C90	N-4	L1	H-1			R19	I-2
C15	K-3	C34	A-2	C53	J-1	C72	H-2	C91		L2		R1		R20	N-2
C16	L-3	C35	A-3	C54	J-3	C73		C92		L3	J-2	R2	K-4	R21	N-2
C17		C36	A-3	C55	J-3	C74		C93	F-3			R3	J-4	R22	N-3
C18	K-4	C37	A-4	C56	J-3	C75		C94	G-3	Q1	J-4	R4	F-2	R23	N-3
C19		C38	C-3	C57	L-4	C76	K-3	C95	F-3	Q2		R5	N-4	R24	

CKT REF	GRID LOC	CKT REF	GRID LOC
R25		R44	M-3
R26	J-2	R45	M-2
R27	J-2	R46	J-1
R28	K-2	R47	M-2
R29	K-2	R48	M-2
R30	K-2	R49	L-2
R31	K-2	R50	K-2
R32	K-2	R51	K-3
R33	M-2	R52	K-3
R34	N-2	R53	L-3
R35	M-2	R54	L-3
R36	M-1	R55	G-4
R37	N-3	R56	L-4
R38	J-2	R57	L-4
R39	N-2	R58	L-4
R40	K-2	R59	L-4
R41	K-2	R60	B-2
R42	M-2	R61	
R43	G-4	R62	K-2

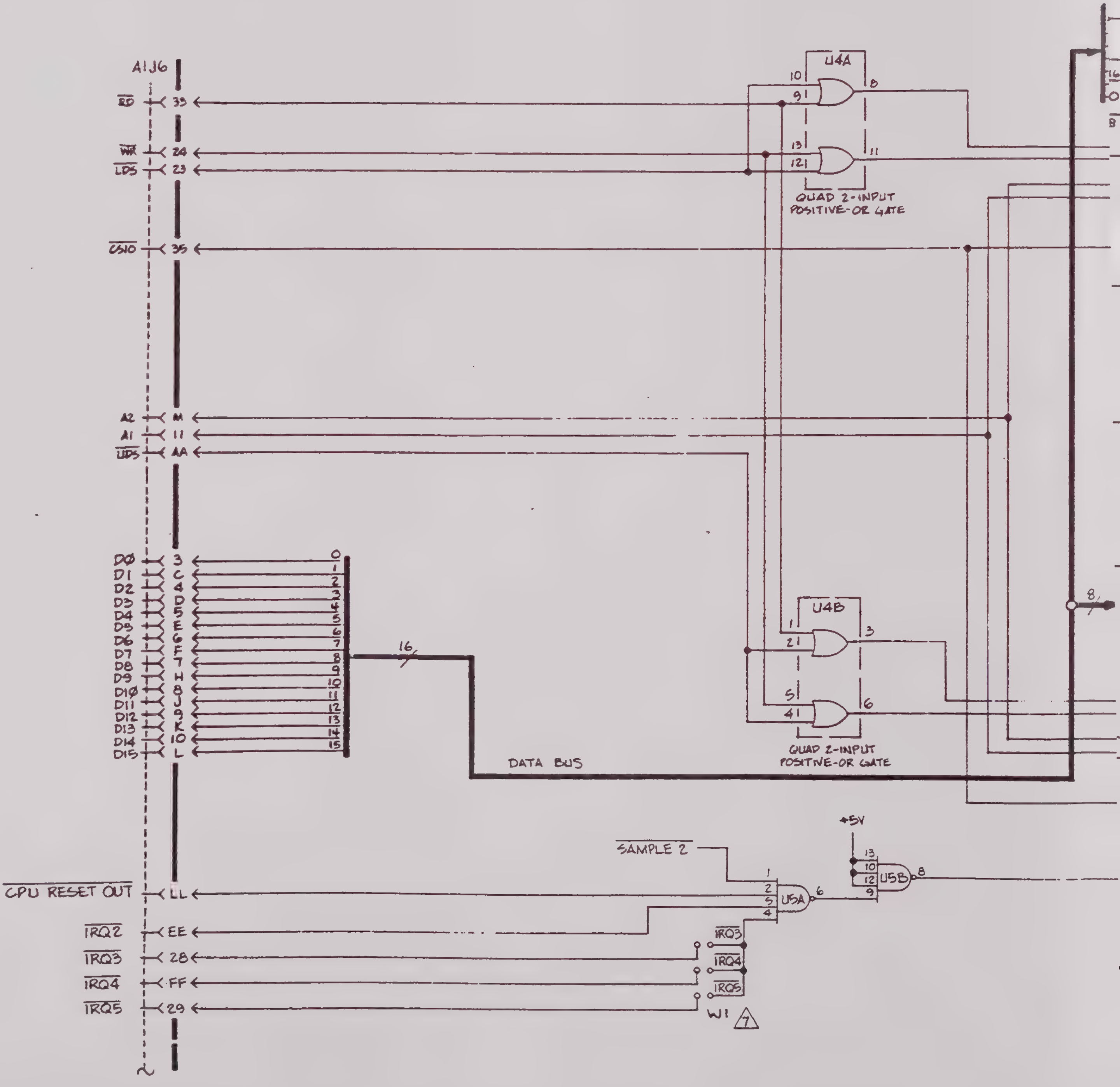

J
K
L
M
N
O
C53
R46
R64
C80
C84
C33
R36
TP6
TP10
Q9
R30
U32
U36
TP9
R39
L3
Q10
R62
C27
C100
C32
C29
C30
R35
TP15
C23
U10
R26
R27
R38
R41
U33
C101
TP11
R49
CR1
U37
U38
C28
R48
R20
C24
R23
C54
Q6
Q5
Q7
Q8
C63
C15
TP12
R53
R54
R44
C9
R37
C77
C78
C14
C76
C86
C55
U35
C70
U34
C16
RP10
R71
R70
C81
C26
U41
C103
TP7
TP8
C85
C57
R14
R15
R10
R12
R13
R22
R65
C58
C18
U39
C62
C22
C25
C61
R3
C1
R2
R51
R52
RP8
TP13
R73
R74
C69
R11
R72
R69
R6
R5
C89
C11
R16
R75
R76
TP16
R8
R9
R58
R59
TP14
C82
C90
C68
C10
R78
TP17
Q13
Q1
C5
R56
R57
R77
TP18
Q14
MADE IN U.S.A.

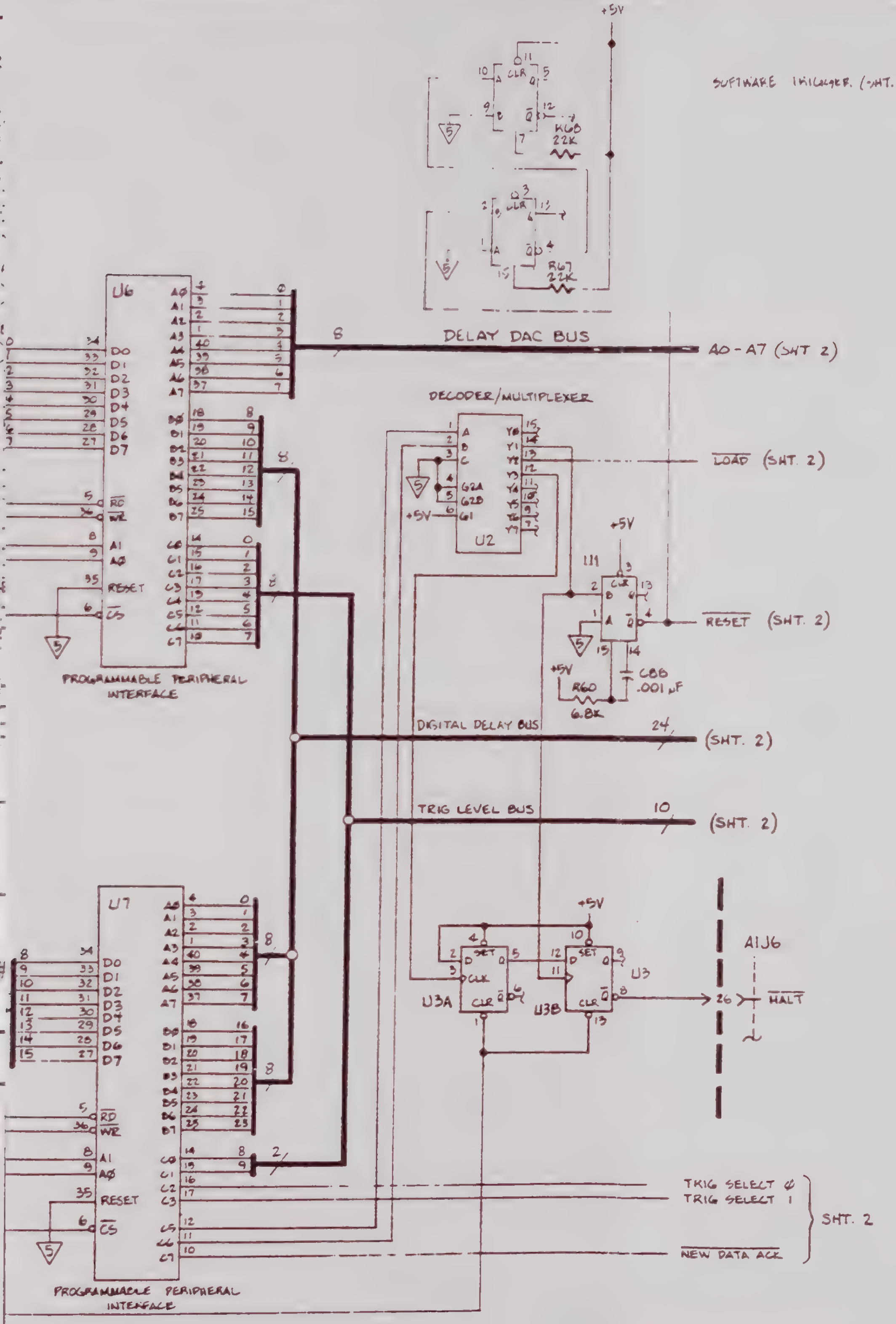
#16685

CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
R63	M-2	RP1	I-4	TP7	J-3	U6	C-2	U25	H-3	Y1	H-2
R64	K-1	RP2	J-2	TP8	K-3	U7	D-2	U26	H-4		
R65		RP3	I-3	TP9	L-2	U8	E-2	U27	J-2	W1	E-4
R66	I-3	RP4	I-2	TP10	M-1	U9	E-2	U28	J-2		
R67	G-2	RP5	G-2	TP11	L-3	U10	E-3	U29	I-3		
R68	G-2	RP6	I-3	TP12	L-3	U11	E-3	U30	I-3		
R69	N-4	RP7	I-4	TP13	L-4	U12	E-4	U31	I-4		
R70	M-3	RP8	L-4	TP14	L-4	U13	E-2	U32	L-2		
R71	M-3	RP9	I-2	TP15	N-2	U14	F-2	U33	L-2		
R72	N-4	RP10	M-3	TP16	M-4	U15	F-3	U34	L-3		
R73	M-4	RP11	F-2	TP17	M-4	U16	F-3	U35	L-3		
R74	M-4			TP18	M-5	U17	F-4	U36	M-2		
R75	M-4					U18		U37	M-2		
R76	M-4	TP1	H-1			U19	G-2	U38	M-3		
R77	M-4	TP2	H-1	U1	B-2	U20	G-3	U39	M-3		
R78	M-4	TP3	H-1	U2	B-2	U21	G-3	U40	N-2		
		TP4	I-1	U3	B-3	U22	G-4	U41	N-3		
		TP5	I-1	U4	B-4	U23	H-2	U42	G-2		
		TP6	K-1	U5	B-4	U24	H-3				

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTOR VALUES IN OHMS, ±5%, 1/4W.
2. ALL UNMARKED RESISTORS 390 OHMS.
3. ALL CAPACITOR VALUES IN MICROFARADS.
4. POWER/GND CHART SHEET 3.
5. U21 PINS 2,6 & 10 ARE CONNECTED TO U21 PIN 1 (VBB).
6. POTENTIOMETER ARROW INDICATES CW ROTATION.
7. JUMPER INSTALLED IN TEST.


A1J6
RD 33
WR 24
LDS 23
CSIO 35
A2 M
A1 11
UDS AA
D0 3
D1 C
D2 4
D3 D
D4 5
D5 E
D6 6
D7 F
D8 7
D9 H
D10 8
D11 J
D12 9
D13 K
D14 10
D15 L
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16
DATA BUS
U4A
10 9 8 13 12 11
QUAD 2-INPUT POSITIVE-OR GATE
U4B
1 2 3 5 4 6
QUAD 2-INPUT POSITIVE-OR GATE
8
+5V
SAMPLE 2
U5A
1 2 5 4 6
U5B
13 10 12 9 8
CPU RESET OUT LL
IRQ2 EE
IRQ3 28
IRQ4 FF
IRQ5 29
IRQ3
IRQ4
IRQ5
W1 7


+5V
SOFTWARE TRIGGER (SHT. 2)
CLR
R68
22K
R67
22K
U6
D0
D1
D2
D3
D4
D5
D6
D7
RD
WR
A1
A0
RESET
CS
A0
A1
A2
A3
A4
A5
A6
A7
B0
B1
B2
B3
B4
B5
B6
B7
C0
C1
C2
C3
C4
C5
C6
C7
PROGRAMMABLE PERIPHERAL INTERFACE
8
DELAY DAC BUS
A0 - A7 (SHT 2)
DECODER/MULTIPLEXER
G2A
G2B
G1
Y0
Y1
Y2
Y3
Y4
Y5
Y6
Y7
U2
LOAD (SHT. 2)
U1
RESET (SHT. 2)
R60
6.8K
C88
.001 µF
DIGITAL DELAY BUS
24
(SHT. 2)
TRIG LEVEL BUS
10
(SHT. 2)
U7
PROGRAMMABLE PERIPHERAL INTERFACE
U3A
U3B
U3
SET
CLK
A1J6
26
HALT
TRIG SELECT 0
TRIG SELECT 1
NEW DATA ACK
SHT. 2

ASSEMBLY 16685

REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A5

REF. DESG.	DEVICE
U1	74LS221
U2	74LS138
U3	74LS74
U4	74LS32
U5	74LS20
U6, U7	8255

DRAWN C. SCHMID DATE 7-30-85
CHECKED 9-5-87
ENG H. Kei 3-5-87
MFG ENG 3-5-87
QA 3-6-87

WAVETEK PACIFIC MEASUREMENTS INC

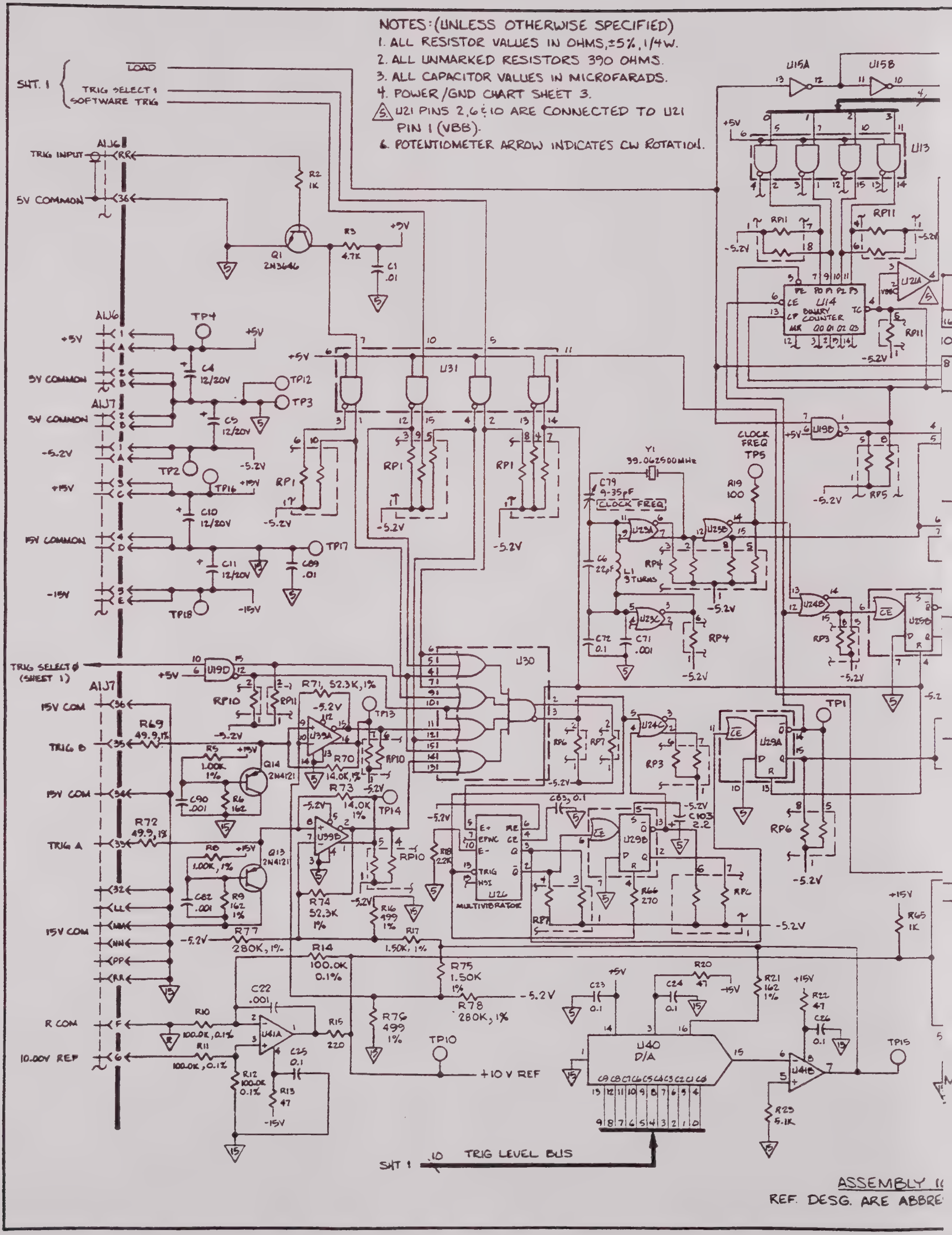
DIGITAL DELAY

DRAWING NO 16686 REV G

SHEET 1 OF 3

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTOR VALUES IN OHMS, ±5%, 1/4W.
2. ALL UNMARKED RESISTORS 390 OHMS.
3. ALL CAPACITOR VALUES IN MICROFARADS.
4. POWER/GND CHART SHEET 3.
5. U21 PINS 2, 6 & 10 ARE CONNECTED TO U21 PIN 1 (VBB).
6. POTENTIOMETER ARROW INDICATES CW ROTATION.

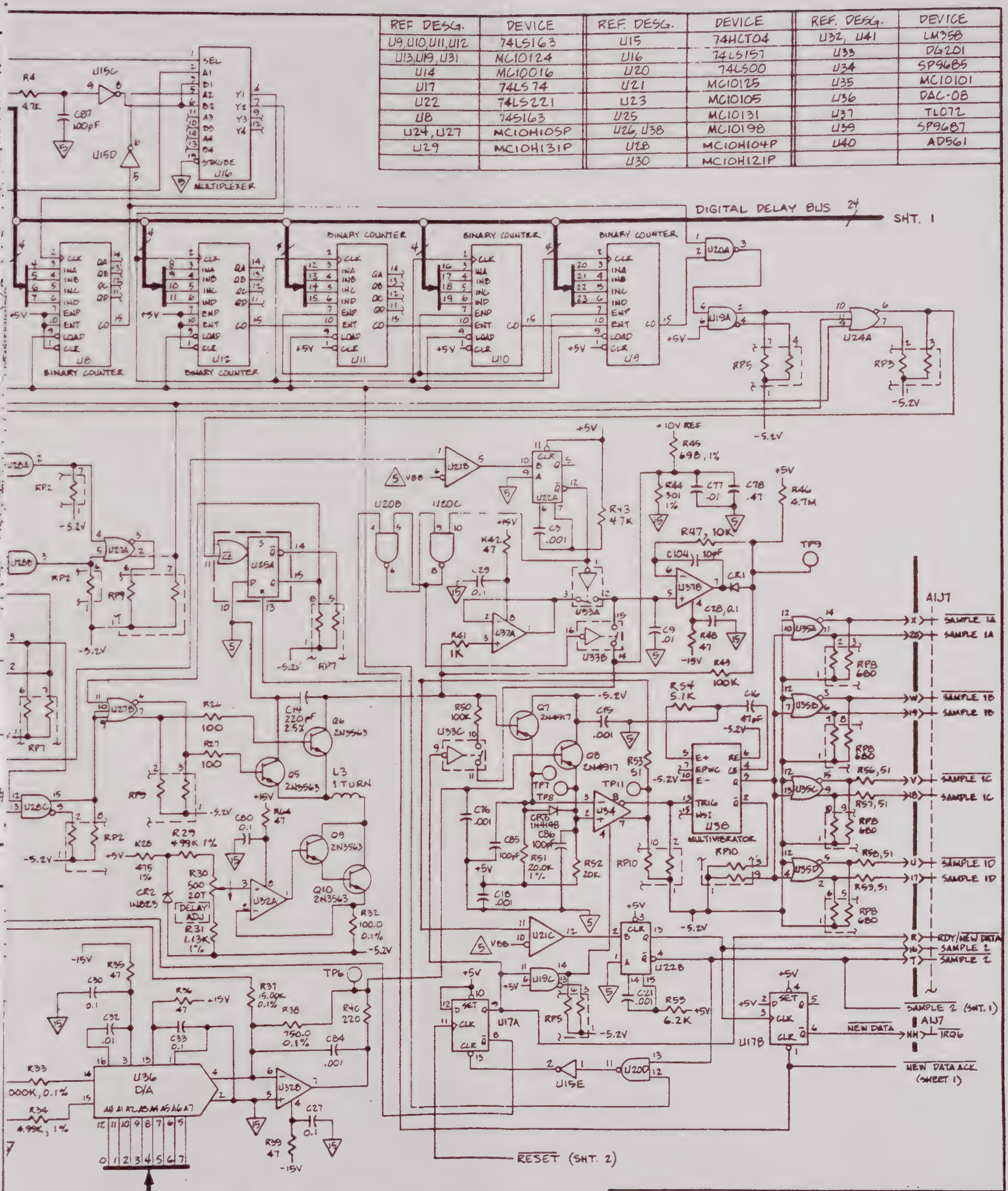


SHT. 1
LOAD
TRIG SELECT 1
SOFTWARE TRIG
TRIG INPUT
A1J6
RR
5V COMMON
36
R2 1K
Q1 2N3646
R3 4.7K
+5V
C1 .01
TP4
+5V
A1J6
5V COMMON
A1J7
5V COMMON
-5.2V
+15V
15V COMMON
-15V
C4 12/20V
C5 12/20V
TP12
TP3
TP2
TP16
TP17
TP18
C10 12/20V
C11 12/20V
C89 .01
U31
RP1
-5.2V
U30
TRIG SELECT 0 (SHEET 1)
U19D
A1J7
15V COM
TRIG B
R69 49.9, 1%
RP10
RP11
R71 52.3K, 1%
U39A
TP13
R5 1.00K 1%
R6 162
Q14 2N4121
C90 .001
R70 14.0K, 1%
R73 14.0K 1%
TP14
U39B
TRIG A
R72 49.9, 1%
R8 1.00K, 1%
Q13 2N4121
C82 .001
R9 162 1%
R74 52.3K 1%
R16 499 1%
R17 1.50K, 1%
R77 280K, 1%
R14 100.0K 0.1%
R75 1.50K 1%
R78 280K, 1%
R COM
R10 100.0K, 0.1%
10.00V REF
R11 100.0K, 0.1%
C22 .001
U41A
R15 220
C25 0.1
R12 100.0K 0.1%
R13 47
-15V
R76 499 1%
TP10
+10 V REF
U26 MULTIVIBRATOR
R18 2.2K
C83, 0.1
U29B
C103 2.2
R66 270
RP6
RP7
RP3
U24C
U29A
TP1
C23 0.1
C24 0.1
R20 47
R21 162 1%
U40 D/A
R22 47
C26 0.1
U41B
TP15
R23 5.1K
R65 1K
SHT 1
TRIG LEVEL BUS
CLOCK FREQ TP5
Y1 39.062500MHz
C79 9-35pF CLOCK FREQ
R19 100
U23A
U25B
RP4
C6 22pF
L1 5 TURNS
U23C
C72 0.1
C71 .001
U24B
U25D
U19D
RP5
U15A
U15B
U13
RP11
U14 BINARY COUNTER
U21A

ASSEMBLY 1(

REF. DESG. ARE ABBRE

REF DESG.	DEVICE	REF. DESG.	DEVICE	REF. DESG.	DEVICE
U9, U10, U11, U12	74LS163	U15	74HCT04	U32, U41	LM358
U13, U19, U31	MC10124	U16	74LS157	U33	DG201
U14	MC10016	U20	74LS00	U34	SP9685
U17	74LS74	U21	MC10125	U35	MC10101
U22	74LS221	U23	MC10105	U36	DAC-08
U8	74S163	U25	MC10131	U37	TL072
U24, U27	MC10H105P	U26, U38	MC10198	U39	SP9687
U29	MC10H131P	U28	MC10H104P	U40	AD561
		U30	MC10H121P		



R4
4.7K
U15C
C87
100pF
U15D
SEL
A1
B1
A2
B2
A3
B3
A4
B4
STROBE
Y1
Y2
Y3
Y4
U16
MULTIPLEXER
DIGITAL DELAY BUS
24
SHT. 1
BINARY COUNTER
CLK
INA
INB
INC
IND
ENP
ENT
LOAD
CLR
QA
QB
QC
QD
CO
+5V
U8
U12
U11
U10
U9
U20A
U19A
U24A
RP5
RP3
-5.2V
+10V REF
R45
698, 1%
R44
301
1%
C77
.01
C78
.47
R46
4.7M
U21B
VBB
U22A
C3
.001
R43
47K
U20B
U20C
R42
47
+15V
C29
0.1
U33A
U37A
R41
1K
U33B
R47, 10K
C104
10pF
U37B
CR1
TP9
C28, 0.1
R48
47
-15V
C9
.01
R49
100K
U28A
RP2
U22A
U28D
RP9
U25A
CE
D
Q
RP7
U27B
R26
100
R27
100
C14
220pF
2.5%
Q6
2N3563
Q5
2N3563
L3
1 TURN
U28C
R29
499K 1%
R28
475
1%
CR2
IN823
R30
500
20T
DELAY ADJ
R31
1.13K
1%
U32A
R14
47
C80
0.1
Q9
2N3563
Q10
2N3563
R32
100.0
0.1%
R50
100K
U33C
Q7
2N4917
Q8
2N4917
C15
.001
R54
5.1K
C16
47pF
R53
51
TP7
TP8
TP11
C76
.001
CR3
1N4148
C85
100pF
C86
100pF
R51
20.0K
1%
R52
20K
U34
C18
.001
E+
EPUC
E-
TRIG
HYS
RE
Q
U38
MULTIVIBRATOR
RP10
U35A
U35B
U35C
U35D
RP8
680
R56, 51
R57, 51
R58, 51
R59, 51
A1J7
SAMPLE 1A
SAMPLE 1B
SAMPLE 1C
SAMPLE 1D
RDY/NEW DATA
SAMPLE 2
SAMPLE 2 (SHT. 1)
NEW DATA
IRQ6
NEW DATA ACK
(SHEET 1)
U21C
U22B
C21
.001
R55
6.2K
U19C
U17A
SET
CLR
U17B
U15E
U20D
TP6
R35
47
C30
0.1
C32
.01
R36
47
R37
15.00K
0.1%
R38
750.0
0.1%
C33
0.1
R40
220
C34
.001
R33
000K, 0.1%
R34
4.99K, 1%
U36
D/A
U32B
C27
0.1
R39
47
-15V
RESET (SHT. 2)
DELAY DAC BUS
8
SHT. 1

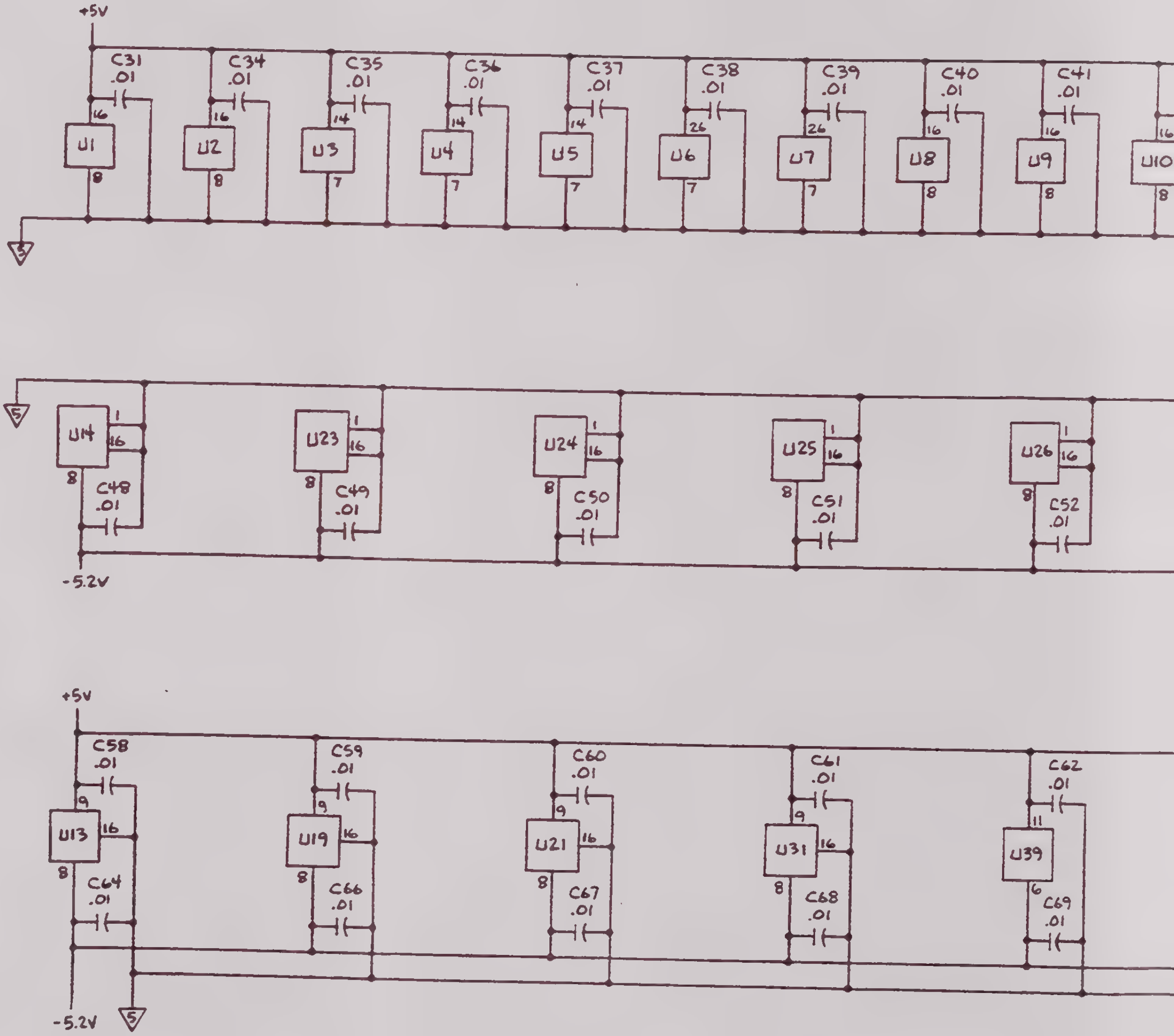
6685
VIATED WITH PREFIX A5

C. SCHMID
DATE
8-2-85
3-5-87
H. Kel
3-5-87
3-5-87
3-6-87

WAVETEK PACIFIC MEASUREMENTS INC

DIGITAL DELAY

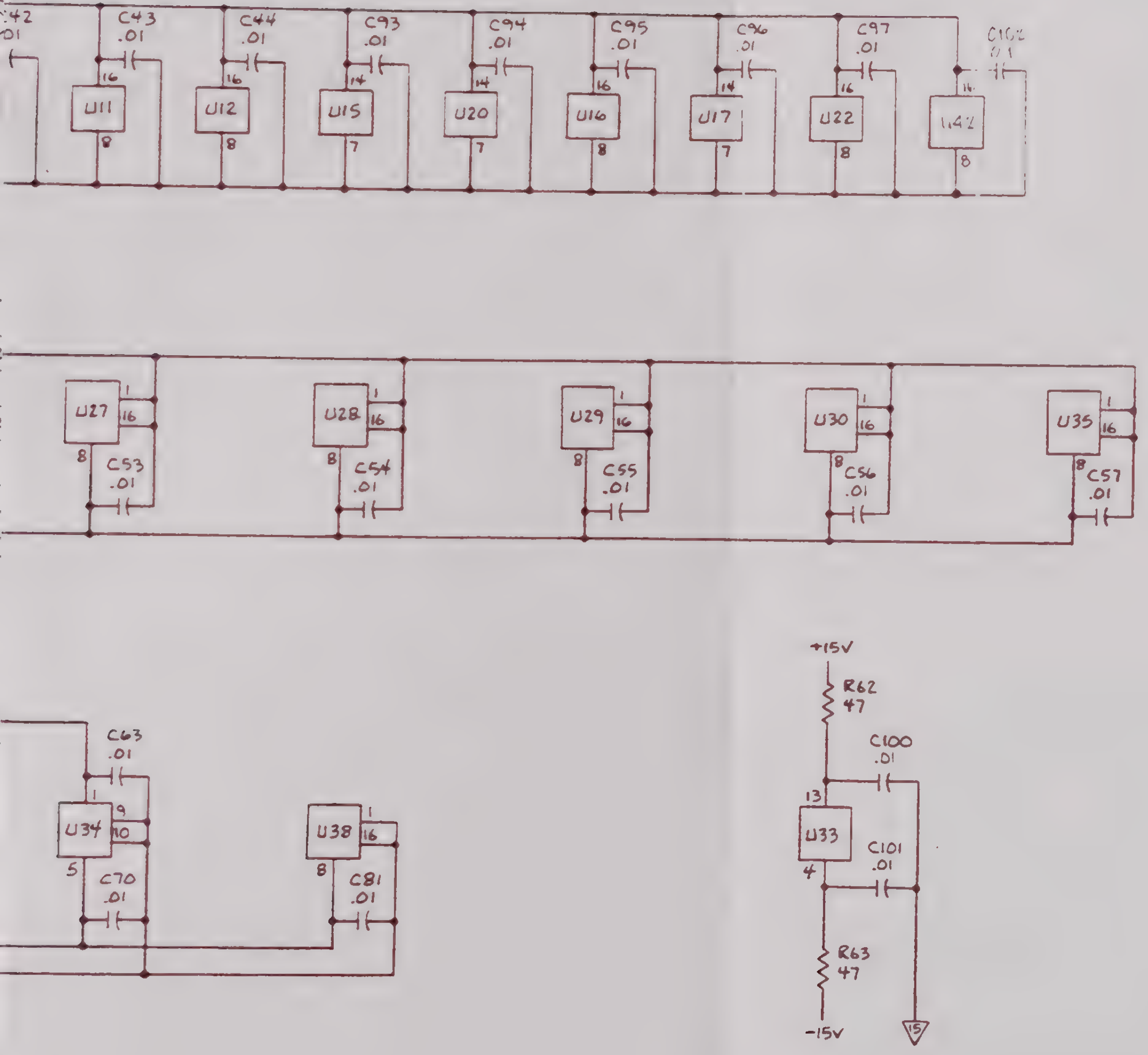
16686 G
SHEET 2 OF 3



+5V
C31 .01
16
U1
8
C34 .01
16
U2
8
C35 .01
14
U3
7
C36 .01
14
U4
7
C37 .01
14
U5
7
C38 .01
26
U6
7
C39 .01
26
U7
7
C40 .01
16
U8
8
C41 .01
16
U9
8
16
U10
8
5
5
U14
1
16
8
C48 .01
U23
1
16
8
C49 .01
U24
1
16
8
C50 .01
U25
1
16
8
C51 .01
U26
1
16
8
C52 .01
-5.2V
+5V
C58 .01
9
U13
16
8
C64 .01
C59 .01
9
U19
16
8
C66 .01
C60 .01
9
U21
16
8
C67 .01
C61 .01
9
U31
16
8
C68 .01
C62 .01
11
U39
6
C69 .01
-5.2V
5

NOTES: (UNLESS OTHERWISE SPECIFIED)
1. RESISTOR VALUES ARE IN OHMS, ±5%, 1/4W.
2. CAPACITOR VALUES ARE IN MICROFARADS.

ASSEM
REF DESIG. ARE


C42
.01
C43
.01
C44
.01
C93
.01
C94
.01
C95
.01
C96
.01
C97
.01
C102
.01
U11
U12
U15
U20
U16
U17
U22
U42
16
14
8
7
U27
U28
U29
U30
U35
1
16
8
C53
.01
C54
.01
C55
.01
C56
.01
C57
.01
C63
.01
U34
1
9
10
5
C70
.01
U38
C81
.01
+15V
R62
47
C100
.01
13
U33
4
C101
.01
R63
47
-15V
15

BLY 16685
ABBREVIATED WITH PREFIX A5

DRAWN 5-30-85
CHECKED 3-5-87
ENG 3-5-87
MFG ENG 3-5-87
QA 3-6-87

WAVETEK PACIFIC MEASUREMENTS INC
SUNNYVALE, CALIFORNIA

DIGITAL DELAY

DRAWING NO. 16686 REV G
SHEET 3 OF 3

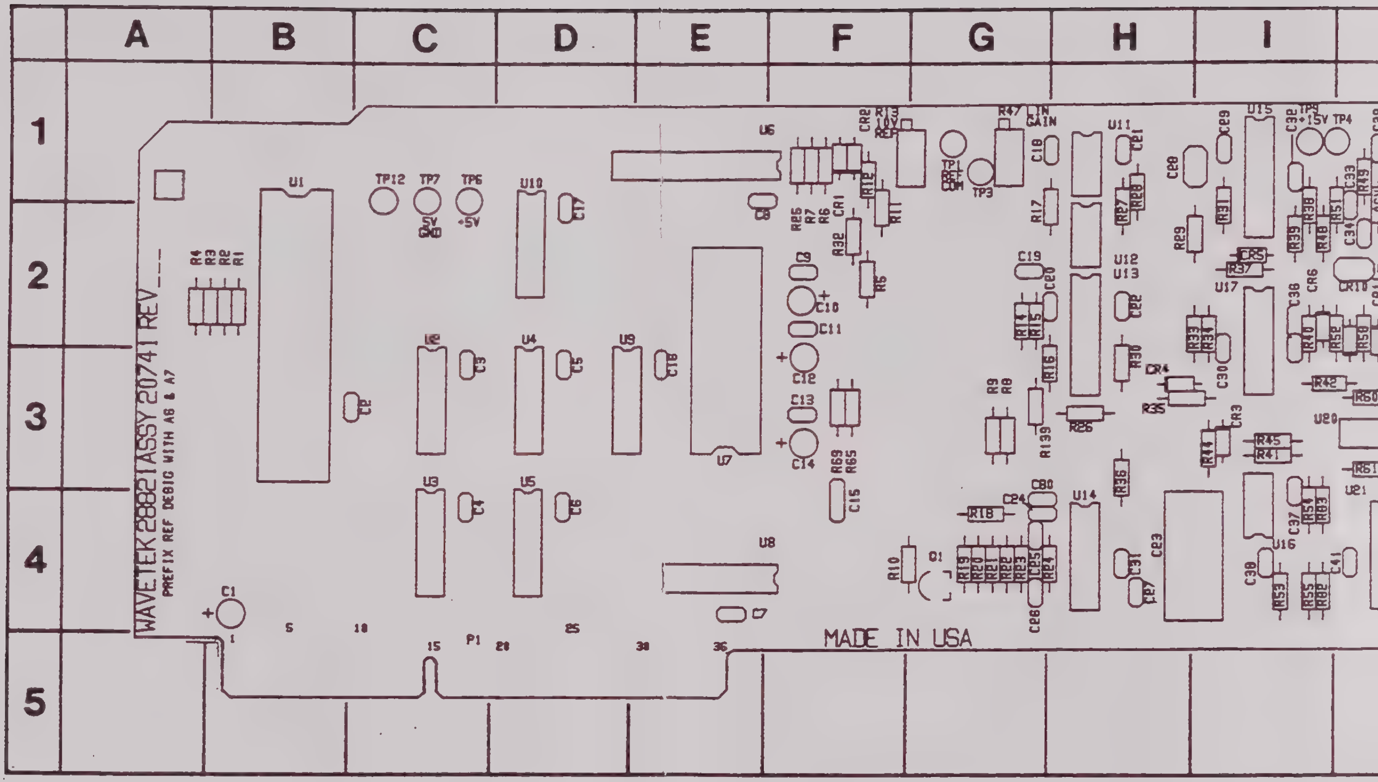
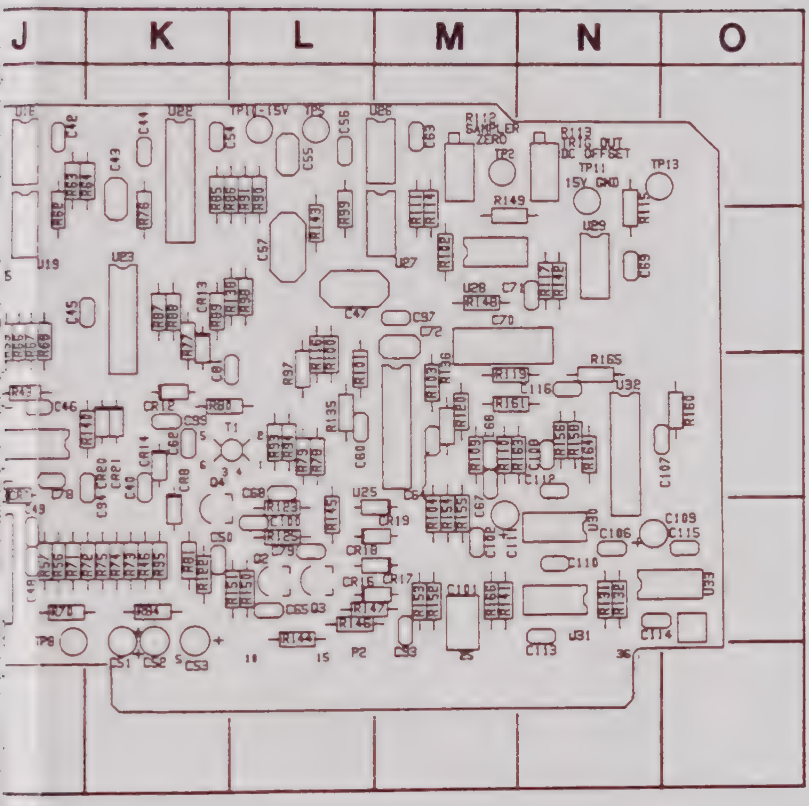

A
B
C
D
E
F
G
H
I
1
2
3
4
5
WAVETEK 288?1 ASSY 20741 REV___
PREFIX REF DEBIG WITH A6 & A7
MADE IN USA
U1
U2
U3
U4
U5
U6
U7
U8
U9
U10
U11
U12
U13
U14
U15
U16
U17
U20
U21
TP1
TP3
TP4
TP5
TP6
TP7
TP12
5V GND
+5V
+15V
P1
Q1
CR1
CR2
CR3
CR4
CR5
CR6
CR10
R47 LIN GAIN
R13 10V REF
COM
1
5
10
15
20
25
30
36

Figure 8-6 Analog PCB Assembly #20741

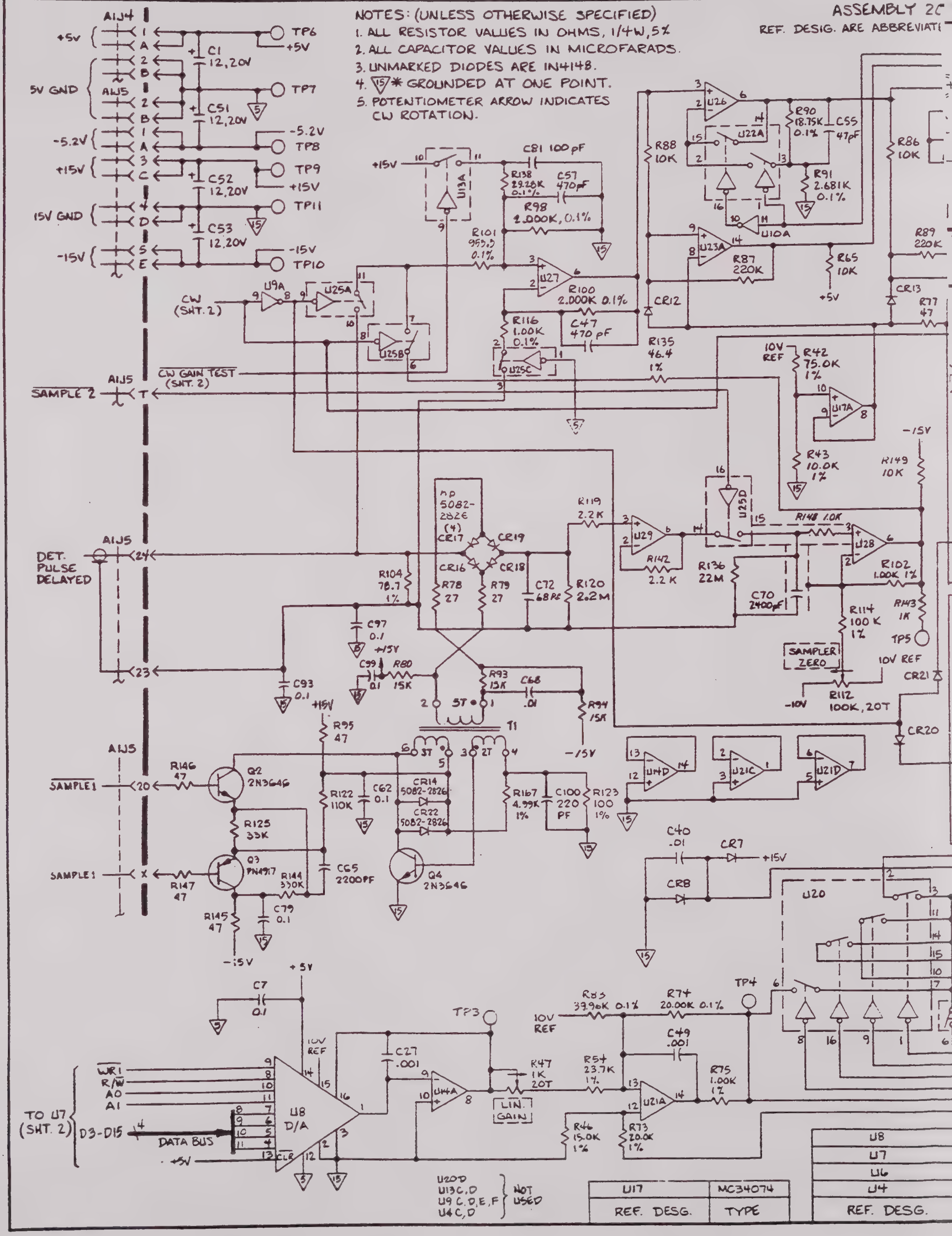
CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
C1	B-4	C20	H-2	C39	J-1	C58		C77		C96		C115	O-4	CR13	K-2
C2	C-3	C21	H-1	C40	K-3	C59		C78	J-3	C97	M-2	C116	N-3	CR14	K-3
C3	C-3	C22	H-2	C41	J-4	C60	L-3	C79	L-4	C98				CR15	
C4	C-4	C23	H-4	C42	J-1	C61		C80	H-4	C99	K-3			CR16	M-4
C5	D-3	C24	H-4	C43	K-1	C62	K-3	C81	L-3	C100	L-4			CR17	M-4
C6	D-4	C25	G-4	C44	K-1	C63	M-1	C82		C101	M-4			CR18	M-4
C7	E-4	C26	G-4	C45	K-2	C64	M-3	C83		C102	M-4			CR19	M-4
C8	E-1	C27	H-4	C46	J-3	C65	L-4	C84		C103		CR1	F-1	CR20	K-3
C9	F-2	C28	I-1	C47	L-2	C66	M-3	C85		C104		CR2	F-1	CR21	K-3
C10	F-2	C29	I-1	C48	J-4	C67	M-3	C86		C105		CR3	I-3		
C11	F-2	C30	I-3	C49	J-4	C68	L-3	C87		C106	N-4	CR4	H-3		
C12	F-3	C31	H-4	C50	K-4	C69	N-2	C88		C107	O-3	CR5	I-2		
C13	F-3	C32	I-1	C51	K-4	C70	M-2	C89		C108	N-3	CR6	I-2	Q1	G-4
C14	F-3	C33	J-2	C52	K-4	C71	N-2	C90		C109	N-4	CR7	J-3	Q2	L-4
C15	F-4	C34	J-2	C53	K-4	C72	M-2	C91		C110	N-4	CR8	K-4	Q3	L-4
C16	E-3	C35	J-2	C54	K-1	C73		C92		C111	M-4	CR9		Q4	K-4
C17	D-2	C36	I-3	C55	L-1	C74		C93	M-4	C112	N-3	CR10	J-2		
C18	H-1	C37	I-4	C56	L-1	C75		C94	K-3	C113	N-4	CR11	J-2		
C19	G-2	C38	I-4	C57	L-2	C76		C95		C114	N-4	CR12	K-3		

CKT REF	GRID LOC	CKT REF	GRID LOC
R1	B-2	R20	G-4
R2	B-2	R21	G-4
R3	B-2	R22	G-4
R4	A-2	R23	G-4
R5	F-2	R24	H-4
R6	F-1	R25	F-1
R7	F-1	R26	H-3
R8	G-3	R27	H-2
R9	G-3	R28	H-2
R10	G-4	R29	I-2
R11	F-2	R30	H-3
R12	F-1	R31	I-2
R13	G-1	R32	I-2
R14	G-2	R33	I-2
R15	G-2	R34	I-2
R16	H-3	R35	H-3
R17	H-2	R36	H-3
R18	G-4	R37	
R19	G-4	R38	I-2


J
K
L
M
N
O
R112 SAMPLER ZERO
R113 TRIG OUT DC OFFSET
TP11 15V GND
TP13
TP10 -15V
TP5
TP2
TP8
U22
U26
U23
U27
U28
U29
U32
U25
U30
U31
U33
U19
T1
C47
C57
C70
C72
C97
C101
C106
C107
C109
C110
C113
C114
C115
C116
C51
C52
C53
R149
R165
R160
R115
R144
R147
R146
R84
R70
R80
R119
R161
P2
15
11
36

CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
R39	I-2	R58	J-2	R77	K-2	R96		R115	N-2
R40	I-2	R59	J-2	R78	L-3	R97	L-3	R116	L-3
R41	I-3	R60	J-3	R79	L-3	R98	L-2	R117	N-2
R42	I-3	R61	J-3	R80	K-3	R99	L-2	R118	
R43	J-3	R62	J-2	R81	K-4	R100	L-3	R119	M-3
R44	I-3	R63	J-1	R82	I-4	R101	L-3	R120	M-3
R45	I-3	R64	K-1	R83	I-4	R102	M-2	R121	
R46	K-4	R65	F-3	R84	K-4	R103	M-3	R122	K-4
R47	G-1	R66	J-2	R85	K-1	R104	M-4	R123	L-4
R48	I-2	R67	J-2	R86	L-1	R105		R124	
R49	J-1	R68	J-2	R87	K-2	R106		R125	L-4
R50	J-2	R69	F-3	R88	K-2	R107		R126	
R51	J-2	R70	J-4	R89	K-2	R108		R127	
R52	J-2	R71	J-4	R90	L-1	R109	M-3	R128	
R53	I-4	R72	K-4	R91	L-1	R110	M-3	R129	
R54	I-4	R73	K-4	R92		R111	M-2	R130	
R55	I-4	R74	K-4	R93	L-3	R112	M-1	R131	N-4
R56	J-4	R75	K-4	R94	L-3	R113	N-1	R132	N-4
R57	J-4	R76	K-2	R95	K-4	R114	M-2	R133	

CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
R134		R153	M-4	T1	L-3	U1	B-2	U20	J-3
R135	L-3	R154	M-4			U2	C-3	U21	J-4
R136	M-3	R155	M-4			U3	C-4	U22	K-1
R137		R156	N-3			U4	D-3	U23	K-2
R138	L-2	R157				U5	D-4	U24	
R139	G-3	R158	N-3	TP1	G-1	U6	E-1	U25	M-3
R140	K-3	R159		TP2	M-1	U7	E-3	U26	M-1
R141	M-4	R160	O-3	TP3	G-1	U8	E-4	U27	M-2
R142	N-2	R161	M-3	TP4	J-1	U9	D-3	U28	M-2
R143	L-2	R162		TP5	L-1	U10	D-2	U29	N-2
R144	L-4	R163	N-3	TP6	C-2	U11	H-1	U30	N-4
R145	L-4	R164	N-3	TP7	C-2	U12	H-2	U31	N-4
R146	L-4	R165	N-3	TP8	J-4	U13	H-2	U32	N-3
R147	L-4	R166	M-4	TP9	I-1	U14	H-4	U33	O-4
R148	M-2			TP10	L-1	U15	I-1		
R149	M-2			TP11	N-1	U16	I-4		
R150	L-4			TP12	C-2	U17	I-2		
R151	L-4			TP13	O-1	U18	J-1		
R152	M-4					U19	J-2		


A1J4
+5V
TP6
+5V
C1 12,20V
5V GND
A1J5
TP7
C51 12,20V
-5.2V
-5.2V
TP8
+15V
TP9
C52 12,20V
+15V
15V GND
TP11
C53 12,20V
-15V
-15V
TP10
+15V
U13A
C81 100pF
R138 29.28K 0.1%
C57 470pF
R98 2.000K, 0.1%
R101 959.9 0.1%
U27
R100 2.000K 0.1%
R116 1.00K 0.1%
C47 470 pF
U25C
CW (SHT. 2)
U9A
U25A
U25B
CW GAIN TEST (SHT. 2)
A1J5
SAMPLE 2
R135 46.4 1%
U26
R88 10K
U22A
R90 18.75K 0.1%
C55 47pF
R91 2.681K 0.1%
U10A
U23A
R87 220K
R65 10K
+5V
CR12
R86 10K
R89 220K
CR13
R77 47
10V REF
R42 75.0K 1%
U17A
R43 10.0K 1%
-15V
R149 10K
hp 5082-2826 (4)
CR17
CR19
CR16
CR18
R78 27
R79 27
C72 68PF
R120 2.2M
R119 2.2K
U29
R142 2.2K
U25D
R148 1.0K
U28
R136 22M
C70 2400pF
R102 1.00K 1%
R114 100K 1%
R143 1K
TP5
SAMPLER ZERO
10V REF
CR21
R112 100K, 20T
-10V
CR20
DET. PULSE DELAYED
A1J5
R104 78.7 1%
C97 0.1
+15V
C99 .01
R80 15K
R93 15K
C68 .01
R94 15K
-15V
5T
T1
C93 0.1
+15V
R95 47
3T
2T
-15V
A1J5
SAMPLE1
R146 47
Q2 2N3646
R122 110K
C62 0.1
CR14 5082-2826
CR22 5082-2826
R167 4.99K 1%
C100 220 PF
R123 100 1%
R125 33K
SAMPLE1
Q3 PN4917
R147 47
R144 330K
C65 2200PF
Q4 2N3646
R145 47
C79 0.1
-15V
U1D
U21C
U21D
C40 .01
CR7
+15V
CR8
U20
C7 0.1
+5V
TP3
TP4
10V REF
R83 39.90K 0.1%
R74 20.00K 0.1%
C49 .001
C27 .001
U14A
R47 1K 20T
LIN. GAIN
R54 23.7K 1%
U21A
R75 1.00K 1%
R46 15.0K 1%
R73 20.0K 1%
10V REF
U8 D/A
WR1
R/W
A0
A1
TO U7 (SHT. 2)
D3-D15
DATA BUS
+5V
CLR

ASSEMBLY 2C

REF. DESIG. ARE ABBREVIATI

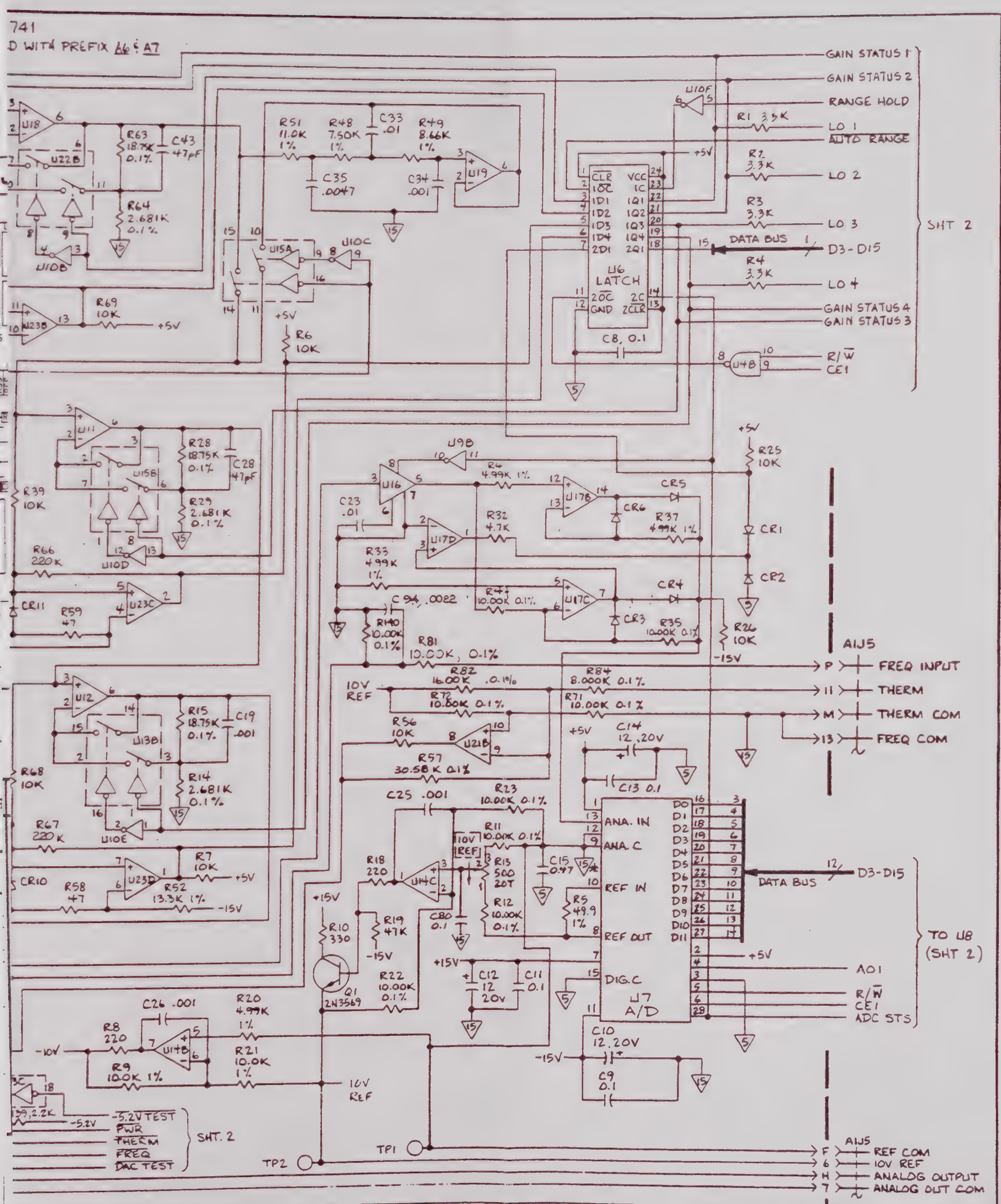
NOTES: (UNLESS OTHERWISE SPECIFIED)
1. ALL RESISTOR VALUES IN OHMS, 1/4W, 5%
2. ALL CAPACITOR VALUES IN MICROFARADS.
3. UNMARKED DIODES ARE 1N4148.
4. (15)* GROUNDED AT ONE POINT.
5. POTENTIOMETER ARROW INDICATES CW ROTATION.

U20D
U13C,D
U9 C,D,E,F
U4C,D
NOT USED

U17	MC34074
REF. DESG.	TYPE

U8
U7
U6
U4
REF. DESG.

741
D WITH PREFIX A6 & A7


GAIN STATUS 1
GAIN STATUS 2
RANGE HOLD
LO 1
AUTO RANGE
LO 2
LO 3
LO 4
GAIN STATUS 4
GAIN STATUS 3
SHT 2
DATA BUS
D3-D15
R/W
CE1
U10F
R1 3.3K
R2 3.3K
R3 3.3K
R4 3.3K
+5V
U6
LATCH
CLR
1OC
1D1
1D2
1D3
1D4
2D1
2OC
GND
VCC
1C
1Q1
1Q2
1Q3
1Q4
2Q1
2C
2CLR
C8, 0.1
U4B
U18
R63 18.7K 0.1%
C43 47pF
U22B
R64 2.681K 0.1%
U10B
R51 11.0K 1%
R48 7.50K 1%
C33 .01
R49 8.66K 1%
C35 .0047
C34 .001
U19
U15A
U10C
R6 10K
U23B
R69 10K
U11
R28 18.75K 0.1%
C28 47pF
U15B
R29 2.681K 0.1%
U10D
R39 10K
R66 220K
U23C
CR11
R59 47
U9B
U16
C23 .01
R4 4.99K 1%
U17B
CR5
CR6
R37 4.99K 1%
U17D
R32 4.7K
R33 4.99K 1%
C94 .0022
R44 10.00K 0.1%
U17C
CR4
CR3
R35 10.00K 0.1%
R140 10.00K 0.1%
R81 10.00K, 0.1%
R25 10K
CR1
CR2
R26 10K
-15V
A1J5
FREQ INPUT
THERM
THERM COM
FREQ COM
10V REF
R82 16.00K 0.1%
R84 8.000K 0.1%
R72 10.00K 0.1%
R71 10.00K 0.1%
R56 10K
U21B
R57 30.58K 0.1%
C14 12, 20V
C13 0.1
U12
R15 18.75K 0.1%
C19 .001
U13B
R14 2.681K 0.1%
U10E
R68 10K
R67 220K
CR10
R58 47
U23D
R7 10K
R52 13.3K 1%
C25 .001
R23 10.00K 0.1%
R11 10.00K 0.1%
10V REF
R13 500 20T
R12 10.00K 0.1%
C15 0.47
R5 49.9 1%
R18 220
U14C
C80 0.1
R10 330
R19 47K
Q1 2N3569
R22 10.00K 0.1%
+15V
C12 12 20V
C11 0.1
ANA. IN
ANA. C
REF IN
REF OUT
DIG. C
U7
A/D
D0
D1
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
DATA BUS
D3-D15
TO U8 (SHT 2)
A01
R/W
CE1
ADC STS
C10 12, 20V
C9 0.1
C26 .001
R8 220
U14B
R20 4.99K 1%
R21 10.0K 1%
R9 10.0K 1%
-10V
10V REF
2.2K
-5.2V
-5.2V TEST
PWR
THERM
FREQ
DAC TEST
SHT. 2
TP1
TP2
A1J5
REF COM
10V REF
ANALOG OUTPUT
ANALOG OUT COM

AD7542	U14, U21	324AN	U28, U29	356
ADS74	U13, U15, U20, U22	201	U25	DG444DJ
ALS873	U11, U12, U18, U19, U26, U27	5135	U23	339
74LS00	U9, U10	74C04	U16	398AN
TYPE	REF. DESG.	TYPE	REF. DESG.	TYPE

DRAWN	Mi. le	10-31-89
CHECKED	Kolln	A-6-90
ENG	Y. Oshima	3/26/90
MFG ENG	H. Kehm	4/6/90
QA		

WAVETEK PACIFIC MEASUREMENTS INC
SUNNYVALE, CALIFORNIA

ANALOG

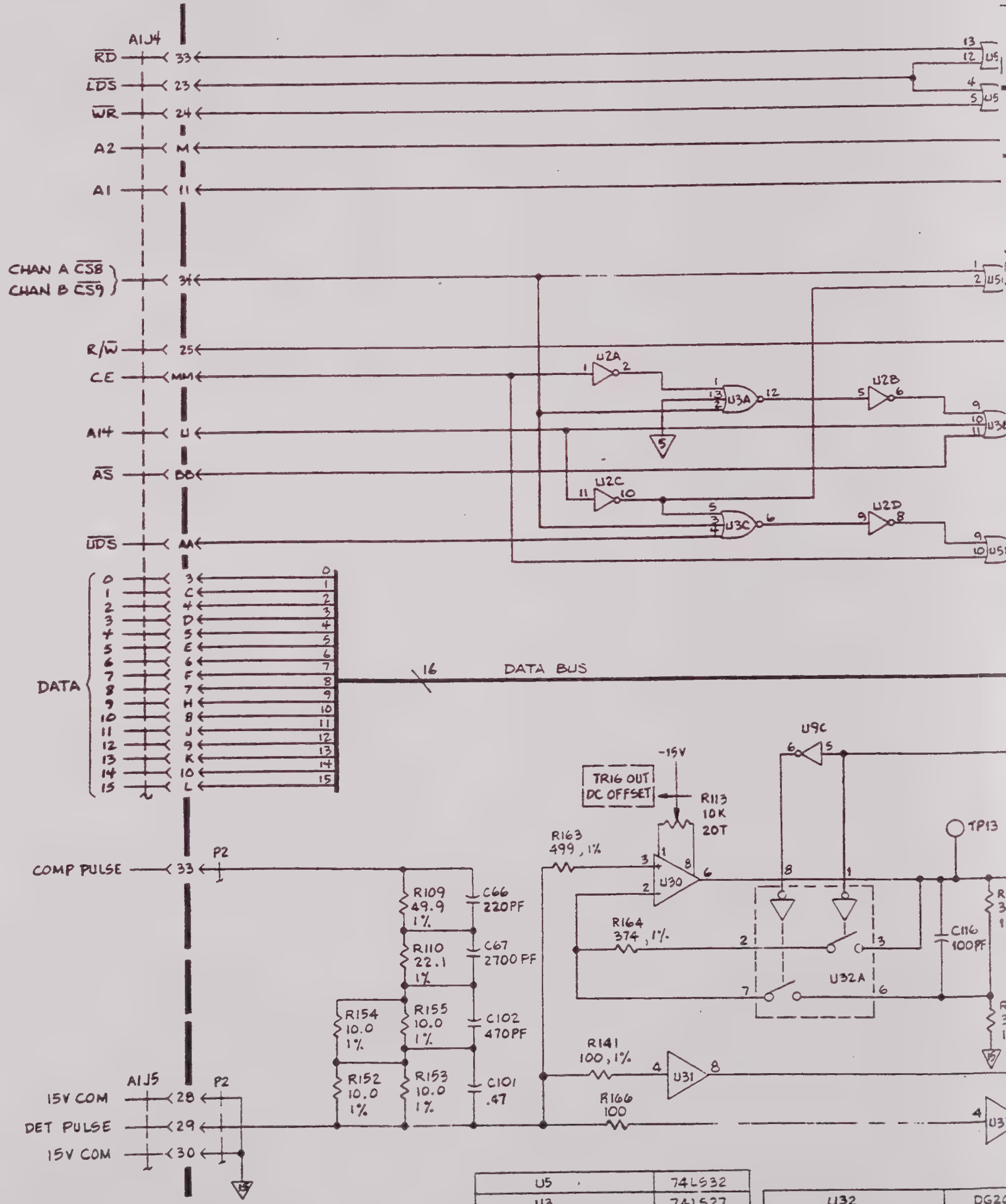
DRAWING NO. 20742 REV H
SHEET 1 OF 3

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTOR VALUES IN OHMS, ± 5%, 1/4 W
2. ALL CAPACITOR VALUES IN MICROFARADS.
3. FOR AUTO RANGE, ØF MUST BE WRITTEN TO U1, A PORT.
4. POTENTIOMETER ARROW INDICATES CW ROTATION.

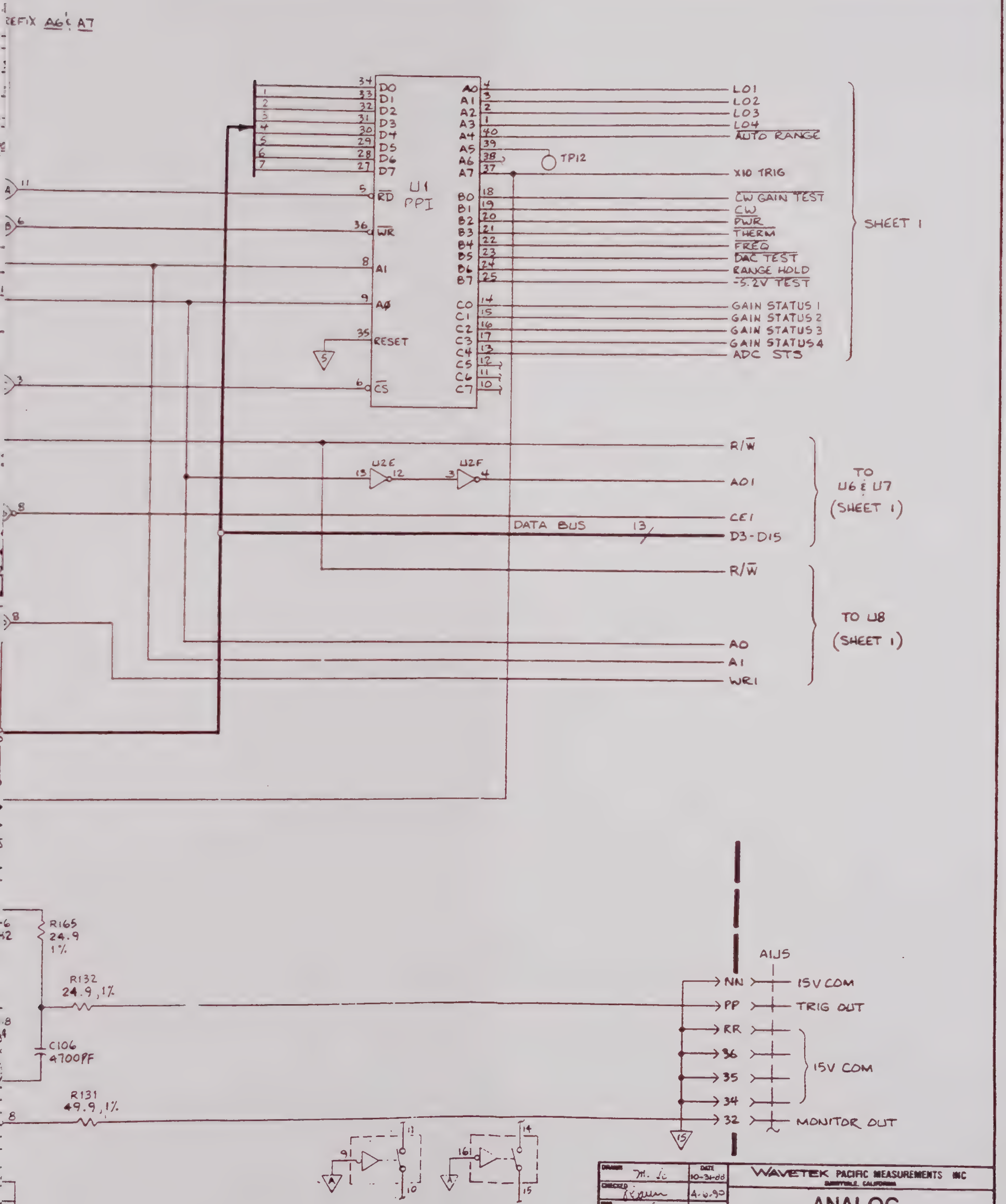
ASSEMBLY 20741

REF DESIG. ARE ABBREVIATED WITH PI


A1J4
RD 33
LDS 23
WR 24
A2 M
A1 11
CHAN A CS8
CHAN B CS9
31
R/W 25
CE MM
A14 U
AS BB
UDS AA
U2A
U3A
U2B
U2C
U3C
U2D
U5
DATA
0 3
1 C
2 4
3 D
4 5
5 E
6 6
7 F
8 7
9 H
10 8
11 J
12 9
13 K
14 10
15 L
16
DATA BUS
U9C
-15V
TRIG OUT DC OFFSET
R113 10K 20T
TP13
R163 499, 1%
U30
R164 374, 1%
U32A
C116 100PF
COMP PULSE 33
P2
R109 49.9 1%
C66 220PF
R110 22.1 1%
C67 2700 PF
R154 10.0 1%
R155 10.0 1%
C102 470PF
R152 10.0 1%
R153 10.0 1%
C101 .47
R141 100, 1%
U31
R166 100
A1J5
15V COM 28
DET PULSE 29
15V COM 30

U5	74LS32
U3	74LS27
U2	74LS04
U1	8255
REF. DESG	TYPE

U32	DG2
U31, U33	HA3-502
U30	AD84
REF. DESG	TYP


REFIX A6 & A7
U1
PPI
D0 D1 D2 D3 D4 D5 D6 D7
RD
WR
A1
A0
RESET
CS
A0 A1 A2 A3 A4 A5 A6 A7
B0 B1 B2 B3 B4 B5 B6 B7
C0 C1 C2 C3 C4 C5 C6 C7
TP12
LO1
LO2
LO3
LO4
AUTO RANGE
X10 TRIG
CW GAIN TEST
CW
PWR
THERM
FREQ
DAC TEST
RANGE HOLD
-5.2V TEST
GAIN STATUS 1
GAIN STATUS 2
GAIN STATUS 3
GAIN STATUS 4
ADC STS
SHEET 1
U2E
U2F
R/W
A01
CE1
DATA BUS
13
D3-D15
TO U6 & U7 (SHEET 1)
R/W
A0
A1
WR1
TO U8 (SHEET 1)
R165 24.9 1%
R132 24.9, 1%
C106 4700PF
R131 49.9, 1%
A1J5
NN
PP
RR
36
35
34
32
15V COM
TRIG OUT
15V COM
MONITOR OUT
15
91
161
11
10
14
15

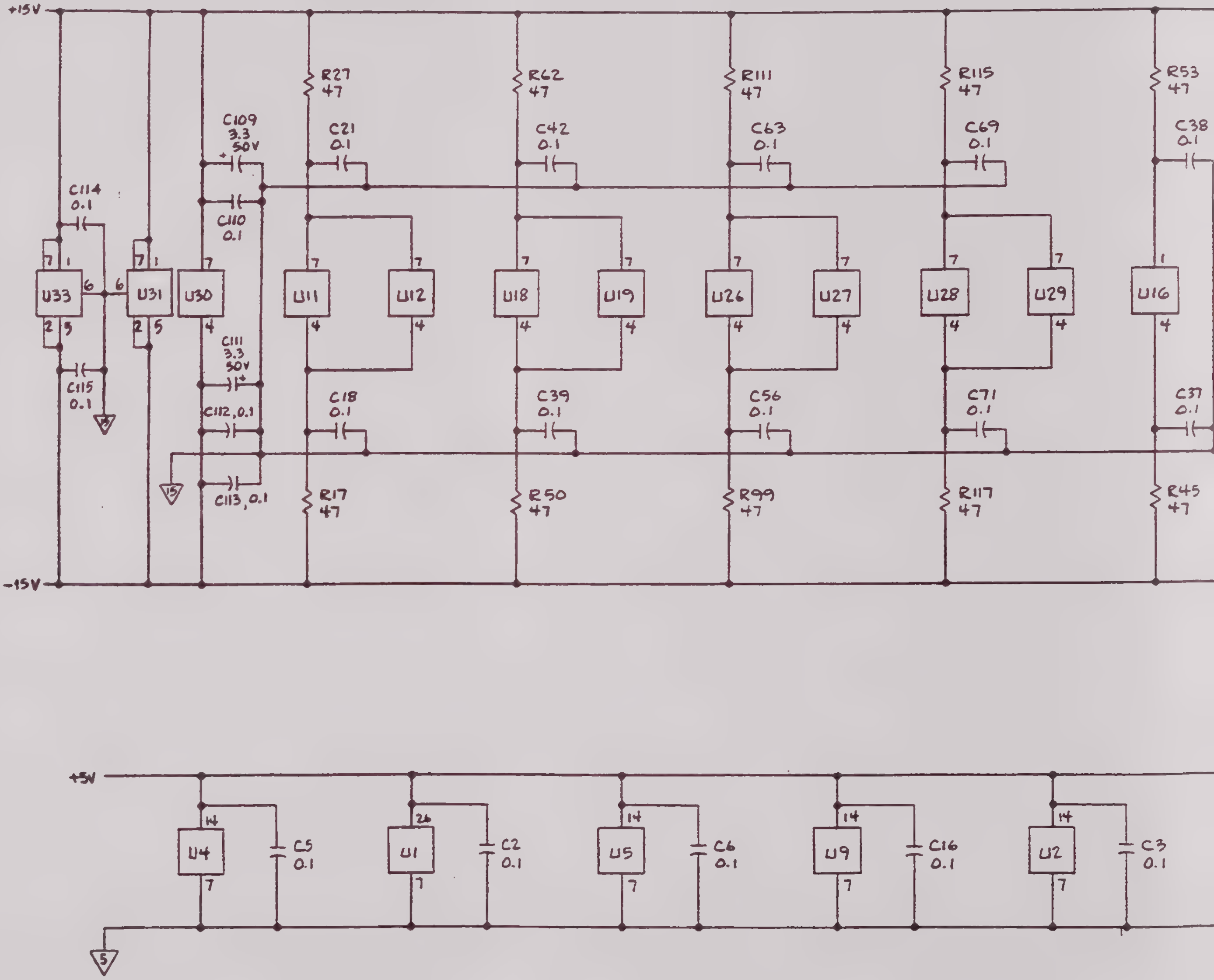
DRAWN M. Li 10-31-88
CHECKED 4-6-90
ENG Y. [illegible] 3/26/90
MFG ENG H. Kehm 4/6/90

WAVETEK PACIFIC MEASUREMENTS INC
SUNNYVALE, CALIFORNIA

ANALOG

20742 H
SHEET 2 OF 3

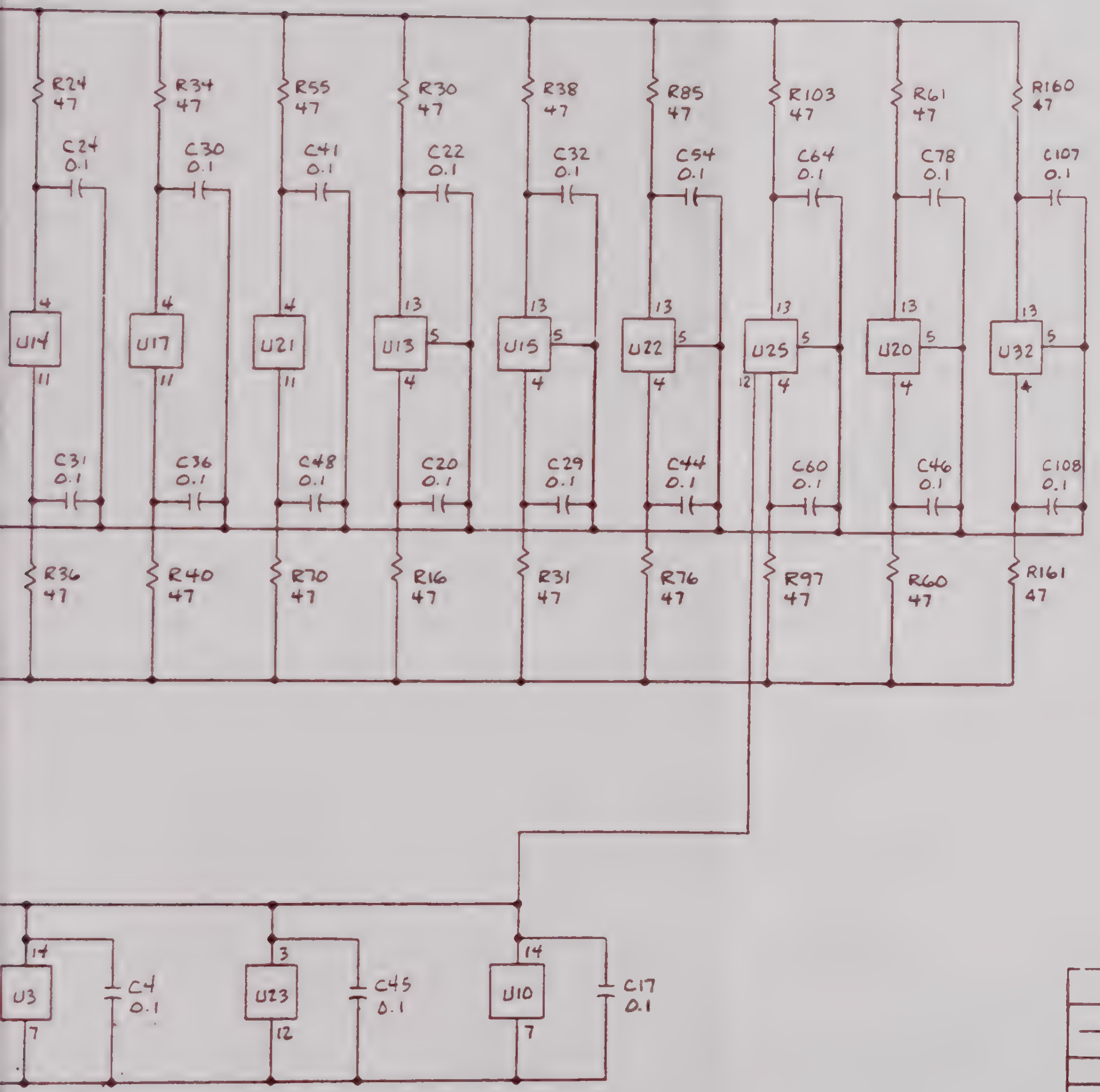
ASSEMBL
REF. DESIG. ARE ABB


+15V
-15V
+5V
C114 0.1
C115 0.1
C109 3.3 50V
C110 0.1
C111 3.3 50V
C112, 0.1
C113, 0.1
U33
U31
U30
U11
U12
U18
U19
U26
U27
U28
U29
U16
R27 47
R62 47
R111 47
R115 47
R53 47
C21 0.1
C42 0.1
C63 0.1
C69 0.1
C38 0.1
C18 0.1
C39 0.1
C56 0.1
C71 0.1
C37 0.1
R17 47
R50 47
R99 47
R117 47
R45 47
15
5
U4
U1
U5
U9
U2
C5 0.1
C2 0.1
C6 0.1
C16 0.1
C3 0.1
14
26
7
4
1
2
5
6

NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%.
2. ALL CAPACITOR VALUES IN MICROFARADS.

Y 20741
REVIATED WITH PREFIX A6 & A7



R24 47
R34 47
R55 47
R30 47
R38 47
R85 47
R103 47
R61 47
R160 47
C24 0.1
C30 0.1
C41 0.1
C22 0.1
C32 0.1
C54 0.1
C64 0.1
C78 0.1
C107 0.1
U14
U17
U21
U13
U15
U22
U25
U20
U32
4
11
13
5
12
C31 0.1
C36 0.1
C48 0.1
C20 0.1
C29 0.1
C44 0.1
C60 0.1
C46 0.1
C108 0.1
R36 47
R40 47
R70 47
R16 47
R31 47
R76 47
R97 47
R60 47
R161 47
U3
U23
U10
14
3
7
12
C4 0.1
C45 0.1
C17 0.1

REF. DESIG	TYPE
U31	OP-37
U30	HA-5033
U17	MC34074
U1	8255
U2	74LS04
U3	74LS27
U4	74LS00
U5	74LS32
U9. U10	74C04
U11. U12, U18. U19, U26. U27	5135
U13, U15, U20, U22, U25, U32	DG201
U14, U21	324AN
U16	398AN
U23	339
,U28, U29	356

DRAWN M. Le	DATE 10-31-89	WAVETEK PACIFIC MEASUREMENTS INC SUNNYVALE, CALIFORNIA
CHECKED	4-6-90	ANALOG
ENG		DRAWING NO. 20742 REV H
MFG ENG		SHEET 3 OF 3

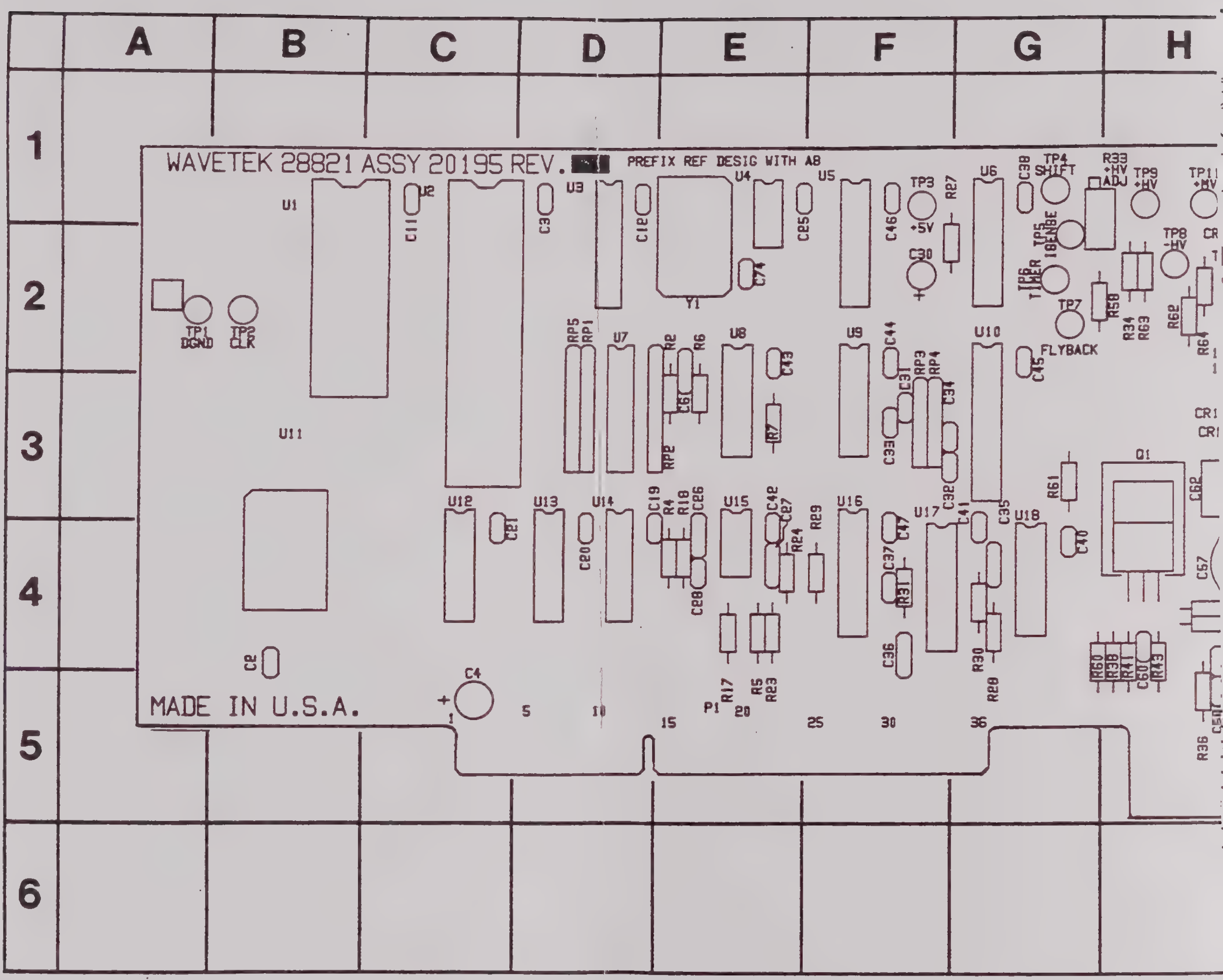
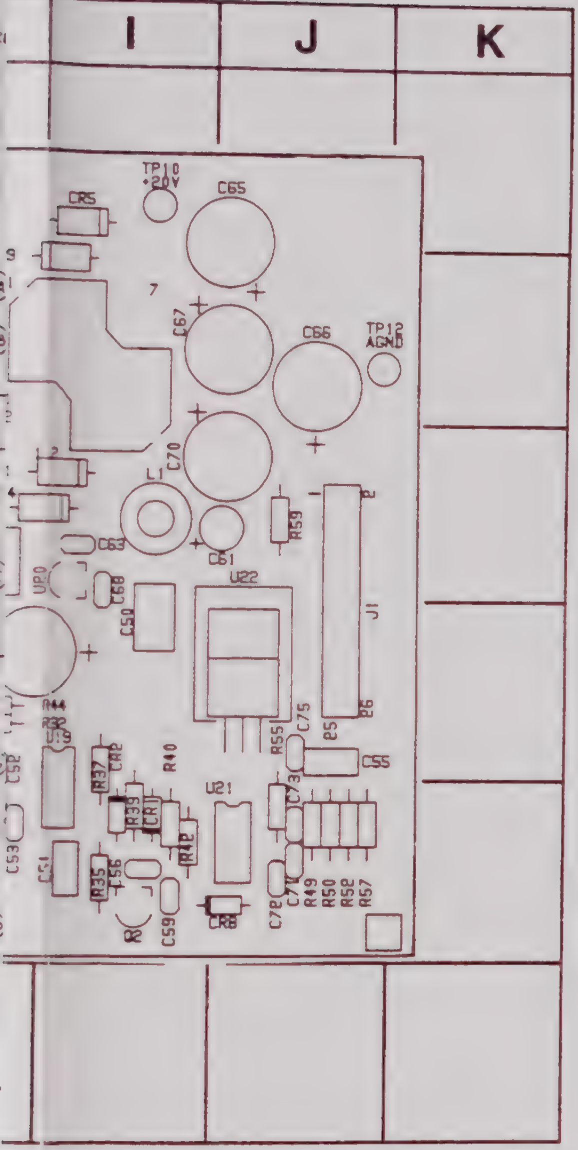

A
B
C
D
E
F
G
H
1
2
3
4
5
6
WAVETEK 28821 ASSY 20195 REV.
PREFIX REF DESIG WITH AB
U1
U2
U3
U4
U5
U6
U7
U8
U9
U10
U11
U12
U13
U14
U15
U16
U17
U18
Y1
Q1
TP1 DGND
TP2 CLK
TP3 +5V
TP4 SHIFT
TP5 IBENBE
TP6 TIMER
TP7
TP8 -HV
TP9 +HV
R33 +HV ADJ
FLYBACK
P1
MADE IN U.S.A.
1
5
10
15
20
25
30
36

Figure 8-7 Front Panel Interface PCB Assembly #20195

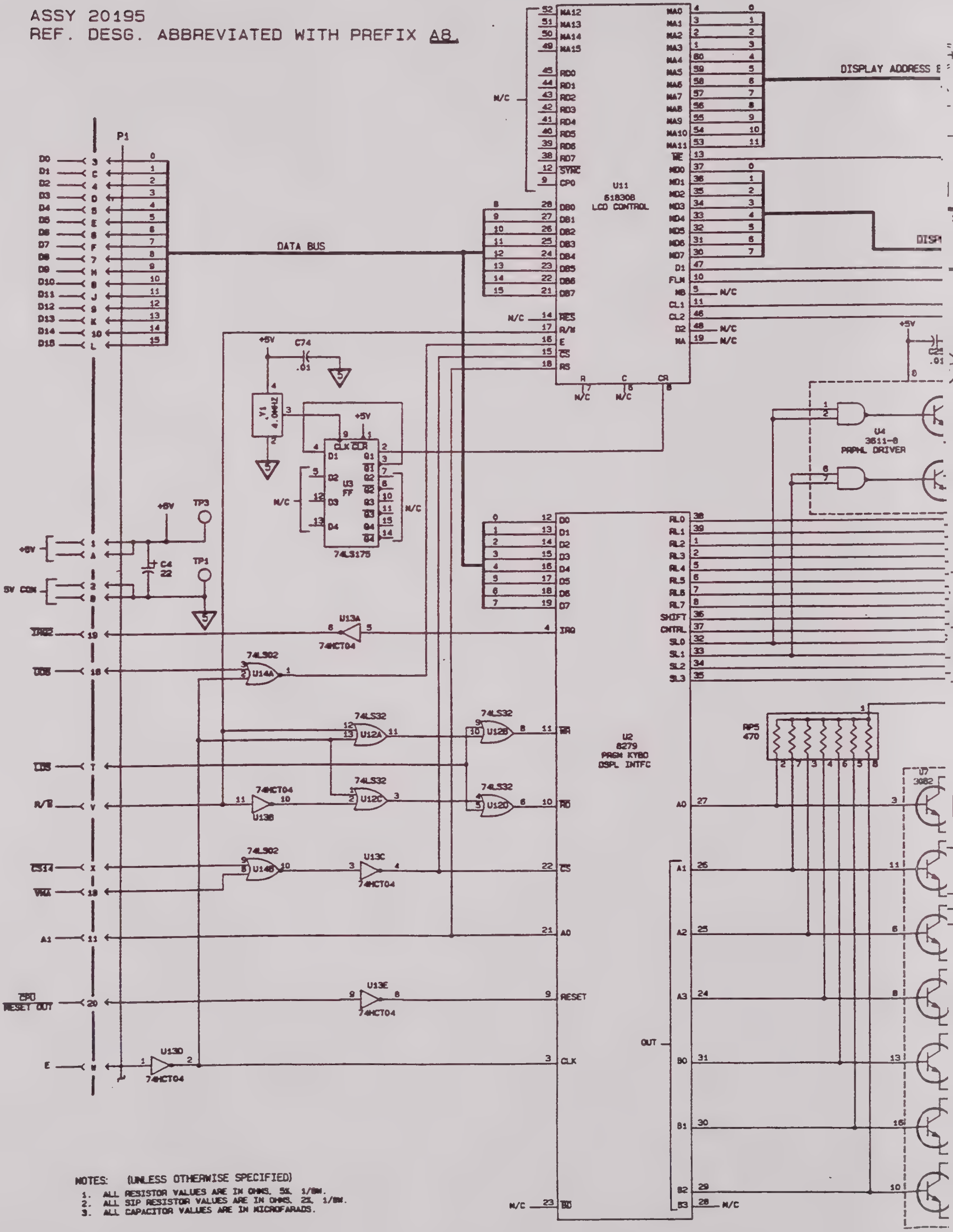
CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	G L
C1		C14		C27	E-4	C40	G-4	C53	H-5	C66	J-2	CR2	I-5	J1	J-4	R5	E
C2	B-4	C15		C28	E-4	C41	G-4	C54		C67	J-2	CR3				R6	E
C3	D-1	C16		C29		C42	E-4	C55	J-4	C68	I-4	CR4				R7	E
C4	C-5	C17		C30	F-2	C43	E-2	C56	I-5	C69		CR5	I-1	L1	I-3	R8	
C5		C18		C31	F-3	C44	F-3	C57	H-4	C70	J-3	CR6				R9	
C6	E-3	C19	D-4	C32	F-3	C45	G-3	C58	H-5	C71	J-5	CR7		Q1	H-3	R10	
C7		C20	D-4	C33	F-3	C46	F-1	C59	I-5	C72	J-5	CR8	J-5	Q2	I-5	R11	
C8		C21	C-4	C34	F-3	C47	F-4	C60	H-4	C73	J-5	CR9	I-2			R12	
C9		C22		C35	G-4	C48		C61	J-3	C74	E-2	CR10				R13	
C10		C23		C36	F-4	C49		C62	H-3	C75	J-4	CR11	I-3	R1		R14	
C11	C-1	C24		C37	F-4	C50	I-4	C63	I-3			CR12		R2	E-3	R15	
C12	D-1	C25	E-1	C38	G-1	C51	I-5	C64				CR13		R3		R16	
C13		C26	E-4	C39		C52	H-5	C65	J-1	CR1	I-5	CR14	I-3	R4	E-4	R17	E


I
J
K
TP10
+20V
CR5
C65
9
7
C67
C66
TP12
AGND
2
C70
L1
R59
C63
C61
U20
C68
C50
U22
J1
R44
R32
U19
C52
R37
CR2
R40
C75
R55
P5
P6
C55
U21
C73
R39
CR1
R42
C53
C51
R35
C56
C71
R49
R50
R52
R57
C72
C59
CR8

CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
R18	E-4	R31	F-4	R44	H-4	R57	J-5	RP4	F-3	TP8	H-2	U7	D-3
R19		R32	H-4	R45		R58	G-2	RP5	D-3	TP9	H-1	U8	E-3
R20		R33	H-1	R46		R59	J-3			TP10	I-1	U9	F-3
R21		R34	H-2	R47		R60	G-4			TP11	H-1	U10	G-3
R22		R35	I-5	R48		R61	G-3	T1	I-2	TP12	J-2	U11	B-4
R23	E-4	R36	H-5	R49	J-5	R62	H-2					U12	C-4
R24	E-4	R37	I-5	R50	J-5	R63	H-2	TP1	A-2			U13	D-4
R25		R38	H-4	R51		R64	H-2	TP2	B-2	U1	B-2	U14	D-4
R26		R39	I-5	R52	J-5			TP3	F-1	U2	C-2	U15	E-4
R27	F-2	R40	I-5	R53				TP4	G-1	U3	D-2	U16	F-4
R28	G-4	R41	H-4	R54		RP1	D-3	TP5	G-2	U4	E-1	U17	F-4
R29	F-4	R42	I-5	R55	J-5	RP2	D-3	TP6	G-2	U5	F-2	U18	G-4
R30	G-4	R43	H-4	R56		RP3	F-3	TP7	G-2	U6	G-2	U19	I-5

CKT REF	GRID LOC
U20	I-3
U21	J-5
U22	J-4
Y1	E-2

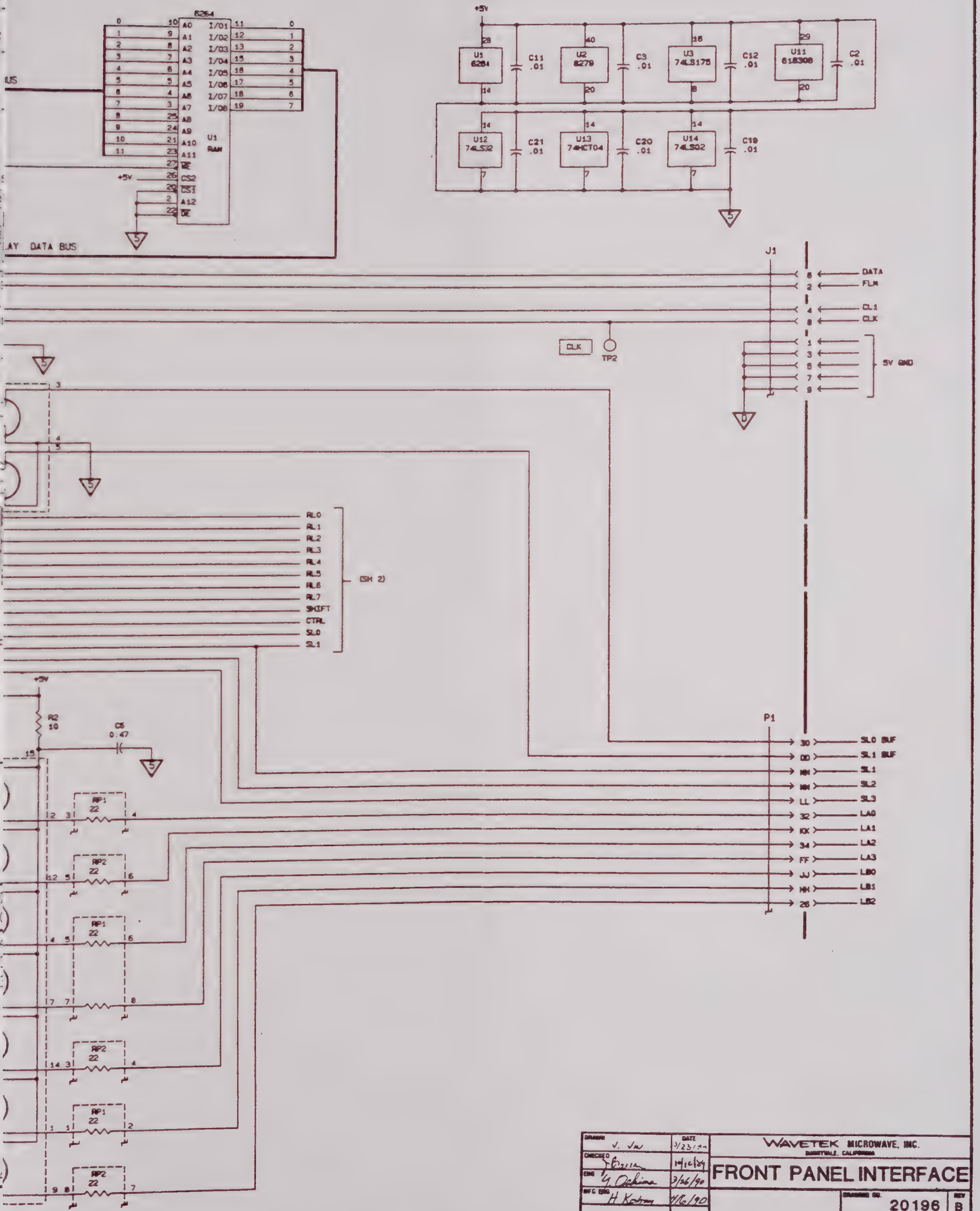
ASSY 20195
REF. DESG. ABBREVIATED WITH PREFIX A8.



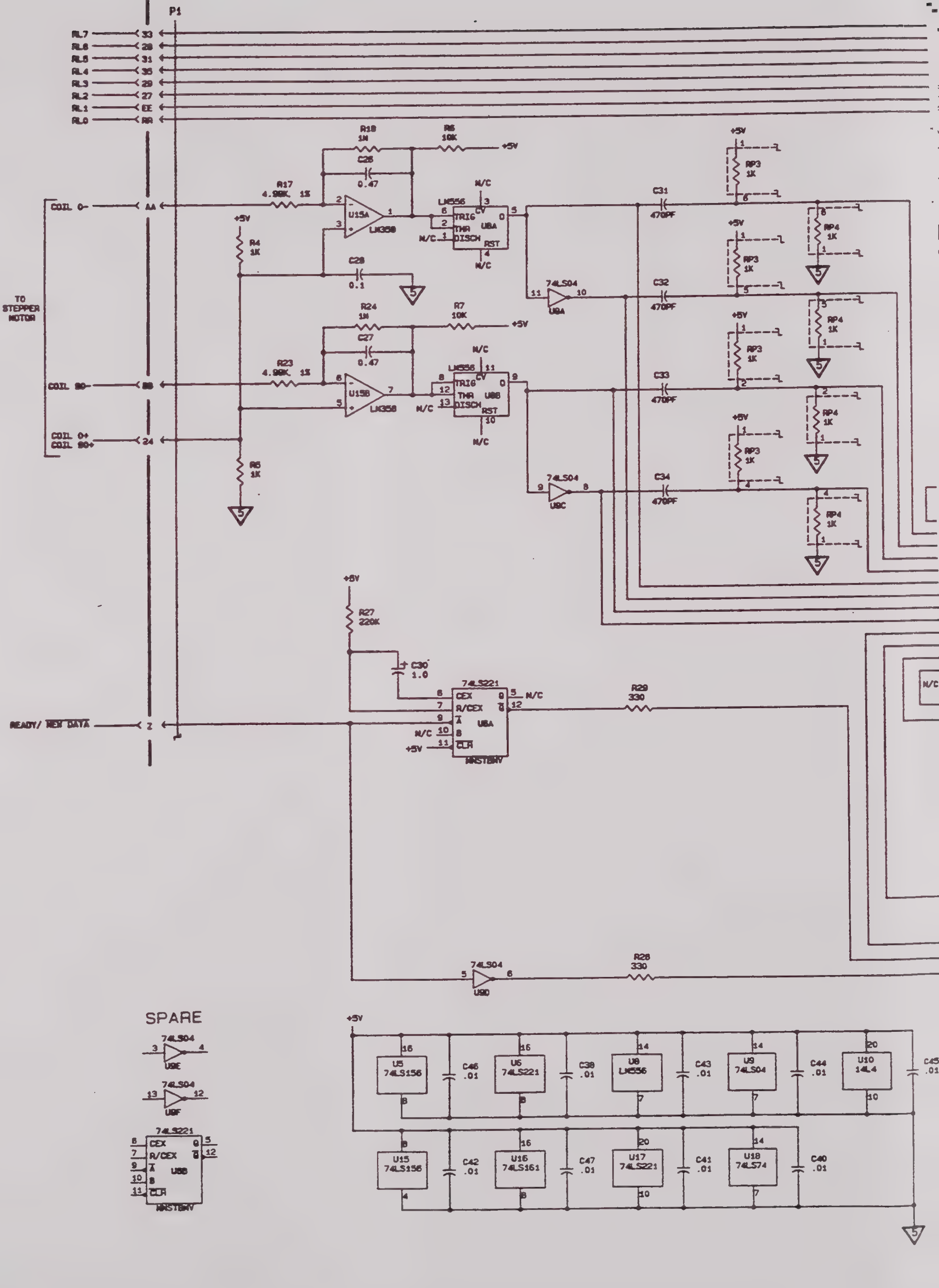
P1
D0
D1
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
D12
D13
D14
D15
DATA BUS
U11
618308
LCD CONTROL
MA12
MA13
MA14
MA15
RD0
RD1
RD2
RD3
RD4
RD5
RD6
RD7
SYNC
CP0
DB0
DB1
DB2
DB3
DB4
DB5
DB6
DB7
RES
R/W
E
CS
RS
MA0
MA1
MA2
MA3
MA4
MA5
MA6
MA7
MA8
MA9
MA10
MA11
WE
MD0
MD1
MD2
MD3
MD4
MD5
MD6
MD7
D1
FLM
MB
CL1
CL2
D2
MA
N/C
DISPLAY ADDRESS B
DISP
+5V
C74
.01
Y1
4.0MHZ
U3
FF
74LS175
CLK
CLR
D1
D2
D3
D4
Q1
Q2
Q3
Q4
U4
3611-8
PRPHL DRIVER
+5V
TP3
TP1
C4
22
5V COM
IRQ2
UDS
LDS
R/W
CS14
VMA
A1
CPU
RESET OUT
E
U13A
74HCT04
74LS02
U14A
74LS32
U12A
U12B
U12C
U12D
74HCT04
U13B
74LS02
U14B
U13C
74HCT04
U13E
74HCT04
U13D
74HCT04
U2
8279
PRGM KYBD
DSPL INTFC
D0
D1
D2
D3
D4
D5
D6
D7
IRQ
WR
RD
CS
A0
RESET
CLK
BD
RL0
RL1
RL2
RL3
RL4
RL5
RL6
RL7
SHIFT
CNTRL
SL0
SL1
SL2
SL3
A0
A1
A2
A3
B0
B1
B2
B3
OUT
RP5
470
U7
3082

NOTES: (UNLESS OTHERWISE SPECIFIED)

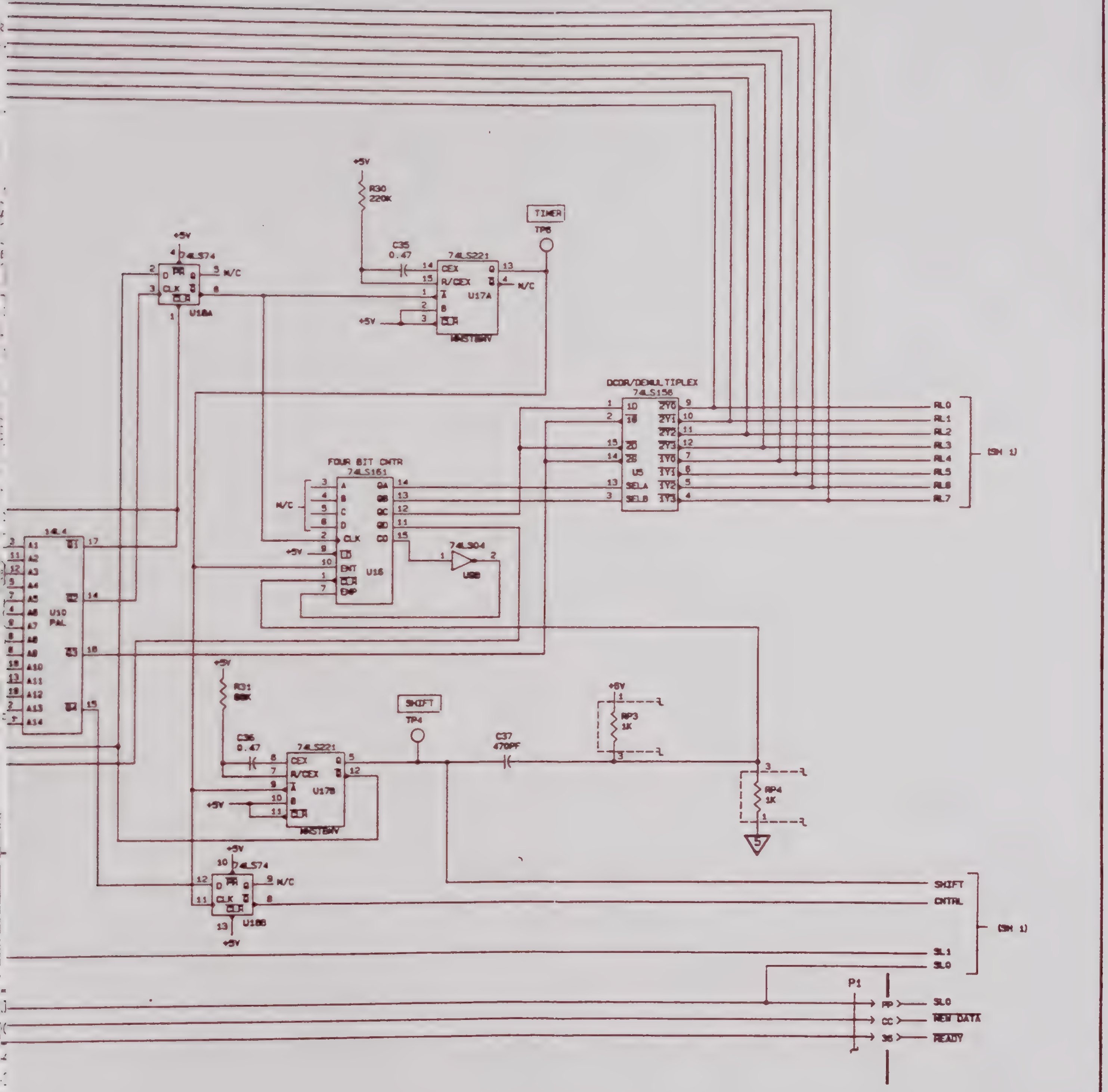
1. ALL RESISTOR VALUES ARE IN OHMS, 5% 1/8W.
2. ALL SIP RESISTOR VALUES ARE IN OHMS, 2% 1/8W.
3. ALL CAPACITOR VALUES ARE IN MICROFARADS.


6264
U1
RAM
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
WE
CS2
CS1
A12
OE
I/01
I/02
I/03
I/04
I/05
I/06
I/07
I/08
+5V
LAY DATA BUS
U1 6264
U2 8279
U3 74LS175
U11 618308
U12 74LS32
U13 74HCT04
U14 74LS02
C11 .01
C3 .01
C12 .01
C2 .01
C21 .01
C20 .01
C19 .01
J1
DATA
FLM
CL1
CLK
5V GND
CLK
TP2
RL0
RL1
RL2
RL3
RL4
RL5
RL6
RL7
SHIFT
CTRL
SL0
SL1
(SH 2)
R2
10
C5
0.47
RP1
RP2
22
P1
SL0 BUF
SL1 BUF
SL1
SL2
SL3
LA0
LA1
LA2
LA3
LB0
LB1
LB2

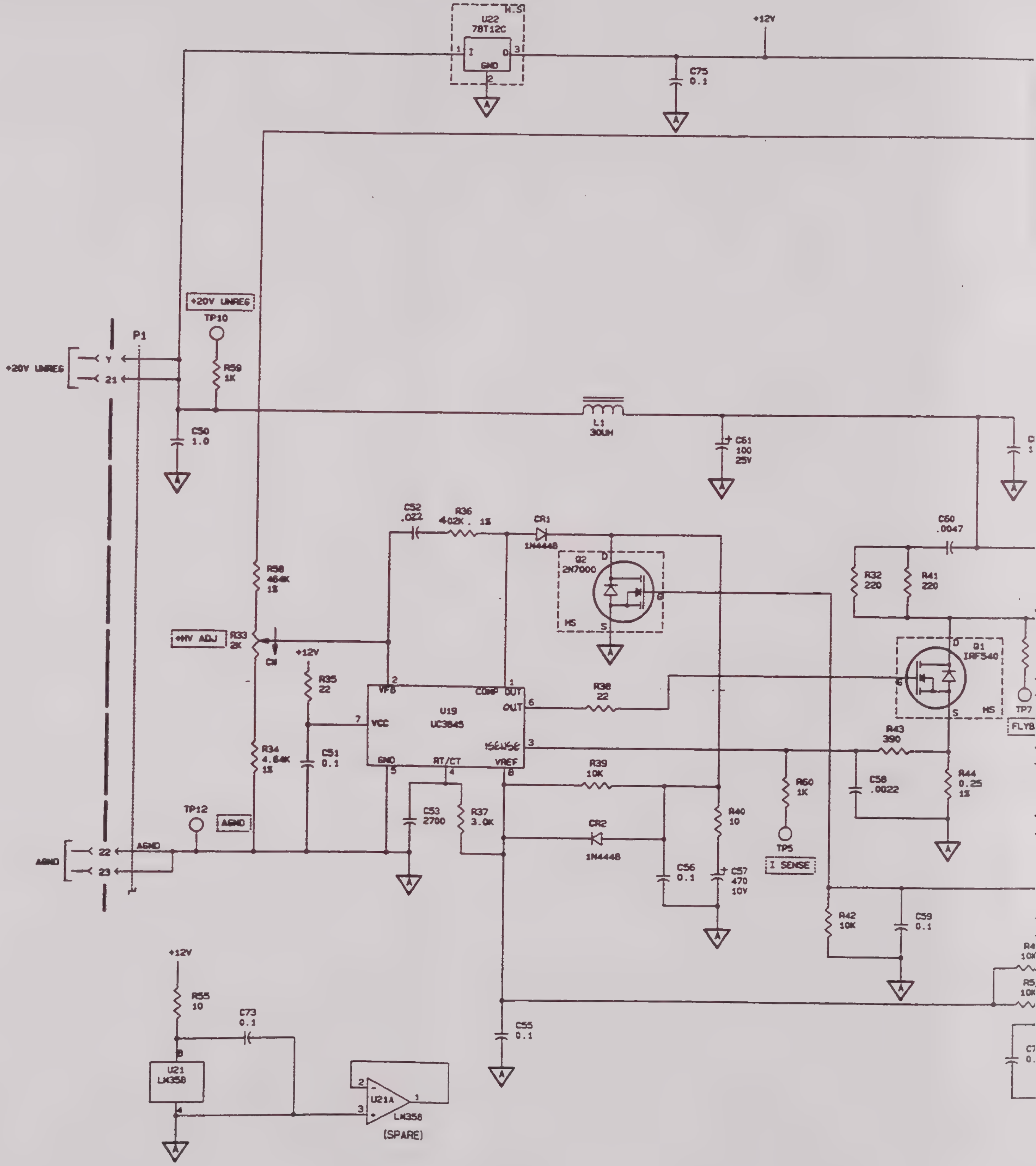
DRAWN	DATE	
V. Jw	3/23/89	WAVETEK MICROWAVE, INC. SUNNYVALE, CALIFORNIA
CHECKED	10/10/89	FRONT PANEL INTERFACE
ENG G. Oshima	3/26/90	
MFG ENG H. Kotzm	4/6/90	DRAWING NO. 20196 REV B
		SHEET 1 OF 3

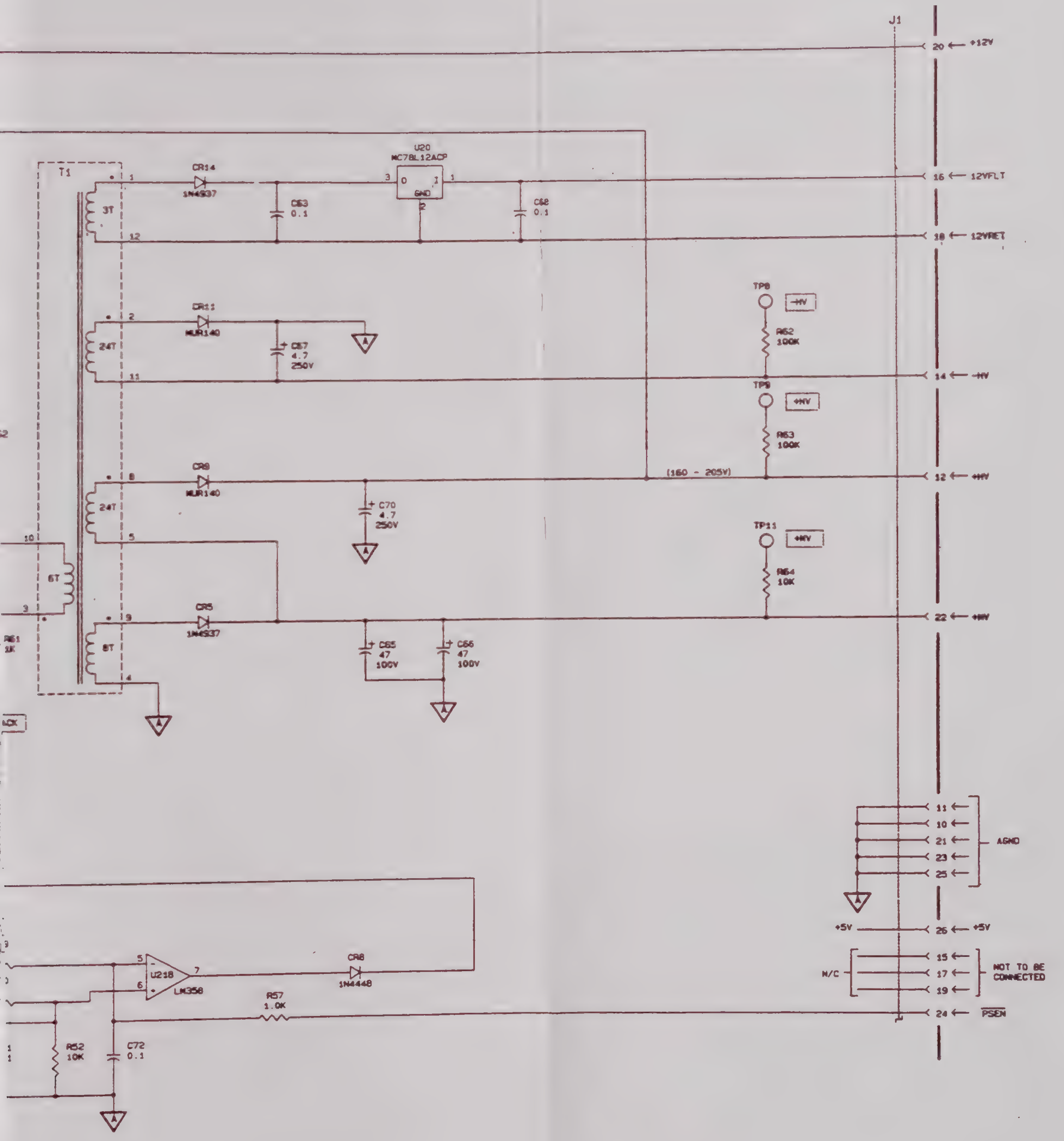


P1
RL7 33
RL6 28
RL5 31
RL4 35
RL3 29
RL2 27
RL1 EE
RL0 RR
TO STEPPER MOTOR
COIL 0- AA
COIL 90- BB
COIL 0+
COIL 90+ 24
READY/ NEW DATA Z
R18 1M
R5 10K
+5V
C25 0.47
R17 4.99K 1%
U15A LM358
LM556 U8A TRIG THR DISCH CV RST Q
N/C
R4 1K
C28 0.1
74LS04 U9A
R24 1M
R7 10K
C27 0.47
R23 4.99K 1%
U15B LM358
LM556 U8B TRIG THR DISCH CV RST Q
R6 1K
74LS04 U9C
C31 470PF
C32 470PF
C33 470PF
C34 470PF
RP3 1K
RP4 1K
R27 220K
C30 1.0
74LS221 U6A CEX R/CEX A B CLR Q
MMSTBNY
R29 330
74LS04 U9D
R28 330
SPARE
74LS04 U9E
74LS04 U9F
74LS221 U6B CEX R/CEX A B CLR
MMSTBNY
U5 74LS156
C46 .01
U6 74LS221
C38 .01
U8 LM556
C43 .01
U9 74LS04
C44 .01
U10 14L4
C45 .01
U15 74LS156
C42 .01
U16 74LS161
C47 .01
U17 74LS221
C41 .01
U18 74LS74
C40 .01
N/C


+5V
R30
220K
TIMER
TP5
C35
0.47
74LS221
CEX
R/CEX
Q
Q̄
A
B
CLR
U17A
MMSTBMV
N/C
+5V
74LS74
D
PR
CLK
CLR
U18A
N/C
DCDR/DEMULTIPLEX
74LS156
1G
1C
2G
2C
U5
SELA
SELB
2Y0
2Y1
2Y2
2Y3
1Y0
1Y1
1Y2
1Y3
RL0
RL1
RL2
RL3
RL4
RL5
RL6
RL7
(SH 1)
FOUR BIT CNTR
74LS161
A
B
C
D
QA
QB
QC
QD
CO
CLK
LD
ENT
CLR
ENP
U16
N/C
+5V
74LS04
U8B
14L4
U10
PAL
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
+5V
R31
68K
C36
0.47
74LS221
CEX
R/CEX
Q
Q̄
A
B
CLR
U17B
MMSTBMV
+5V
SHIFT
TP4
C37
470PF
+5V
RP3
1K
RP4
1K
5
+5V
74LS74
D
PR
Q
CLK
Q̄
CLR
U18B
N/C
+5V
SHIFT
CNTRL
SL1
SL0
(SH 1)
P1
PP
CC
36
SL0
NEW DATA
READY

DRAWN J. Vu	DATE 3/23/83	WAVETEK MICROWAVE, INC. SUNNYVALE, CALIFORNIA
CHECKED J Bauer	10/10/89	FRONT PANEL INTERFACE
ENG Y. Oshima	3/06/90	
MFG. ENG. H. Kahn	4/6/90	DRAWING NO. 20196 REV B
		SHEET 2 OF 3


H.S
U22
78T12C
1
I
O
3
GND
2
+12V
C75
0.1
+20V UNREG
TP10
P1
+20V UNREG
Y
21
R59
1K
C50
1.0
L1
30UH
C61
100
25V
C52
.022
R36
402K . 1%
CR1
1N4448
Q2
2N7000
D
G
S
HS
C60
.0047
R32
220
R41
220
R58
464K
1%
+HV ADJ
R33
2K
CW
+12V
R35
22
2
VFB
COMP
1
OUT
OUT
6
U19
UC3845
7
VCC
ISENSE
3
GND
5
RT/CT
4
VREF
8
C51
0.1
R34
4.64K
1%
R38
22
Q1
IRF540
D
G
S
HS
TP7
FLYB
R43
390
R44
0.25
1%
R39
10K
R60
1K
C58
.0022
TP12
AGND
AGND
22
23
AGND
C53
2700
R37
3.0K
CR2
1N4448
R40
10
C56
0.1
C57
470
10V
TP5
I SENSE
R42
10K
C59
0.1
+12V
R55
10
C73
0.1
8
U21
LM358
4
2
3
U21A
LM358
1
(SPARE)
C55
0.1


J1
20 ← +12V
U20
MC78L12ACP
3
O
I
1
GND
2
T1
CR14
1N4937
C63
0.1
C62
0.1
3T
1
12
16 ← 12VFLT
18 ← 12VRET
CR11
MUR140
C67
4.7
250V
24T
2
11
TP8
-HV
R62
100K
14 ← -HV
TP9
+HV
R63
100K
CR9
MUR140
24T
8
5
(160 - 205V)
12 ← +HV
C70
4.7
250V
TP11
+HV
R64
10K
10
3
6T
CR5
1N4937
8T
9
4
22 ← +HV
C65
47
100V
C66
47
100V
R61
1K
11 ←
10 ←
21 ←
23 ←
25 ←
AGND
+5V
26 ← +5V
N/C
15 ←
17 ←
19 ←
NOT TO BE CONNECTED
U21B
LM358
5
6
7
CR8
1N4448
R57
1.0K
24 ← PSEN
R52
10K
C72
0.1
A

DRAWN V. Vu
DATE 3/29/89
CHECKED [illegible]
ENG Y. Oshima 3/26/90
MFG ENG N. Kehm 4/6/90

WAVETEK MICROWAVE, INC.
SUNNYVALE, CALIFORNIA

FRONT PANEL INTERFACE

DRAWING NO. 20196
REV B
SHEET 3 OF 3

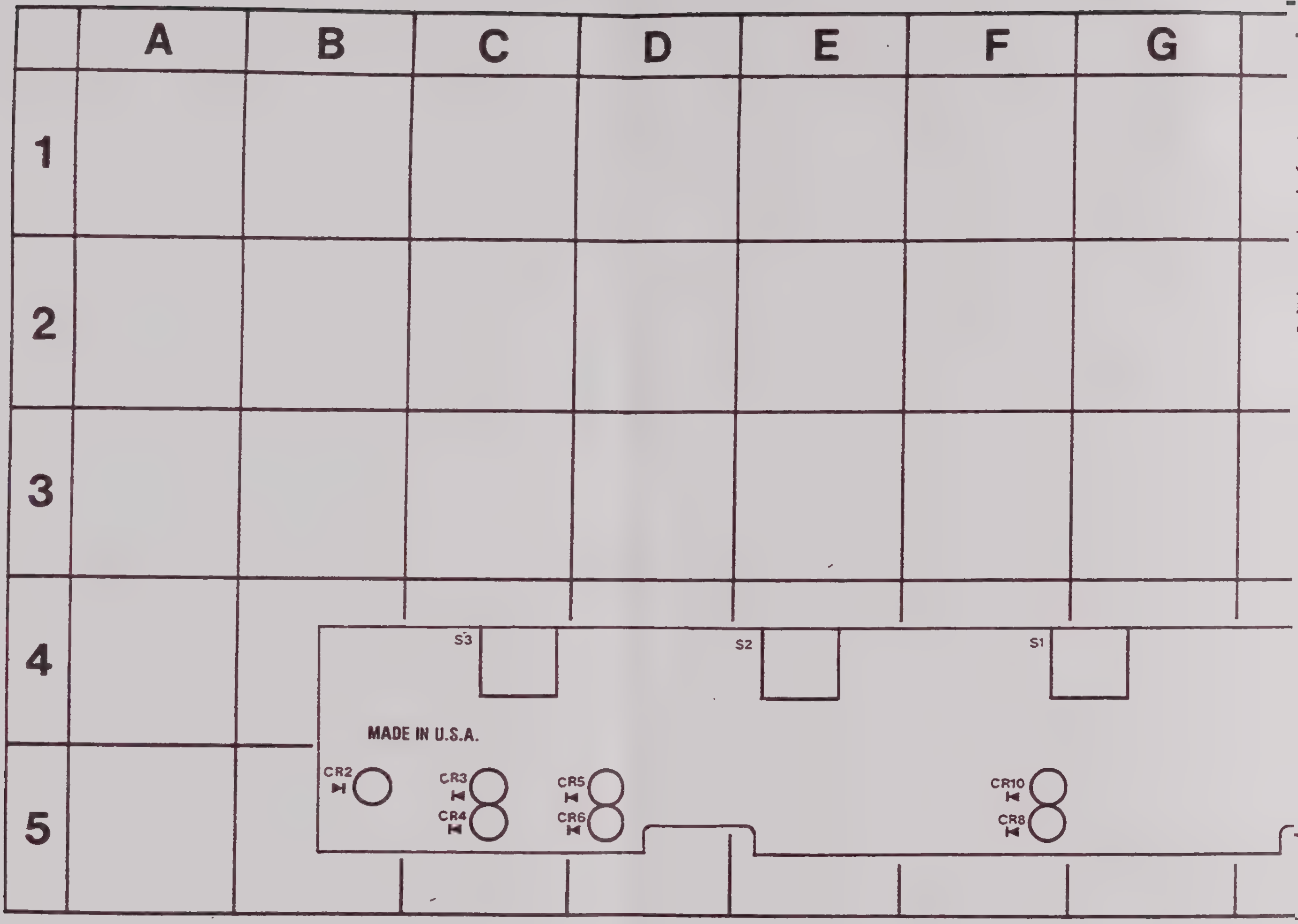
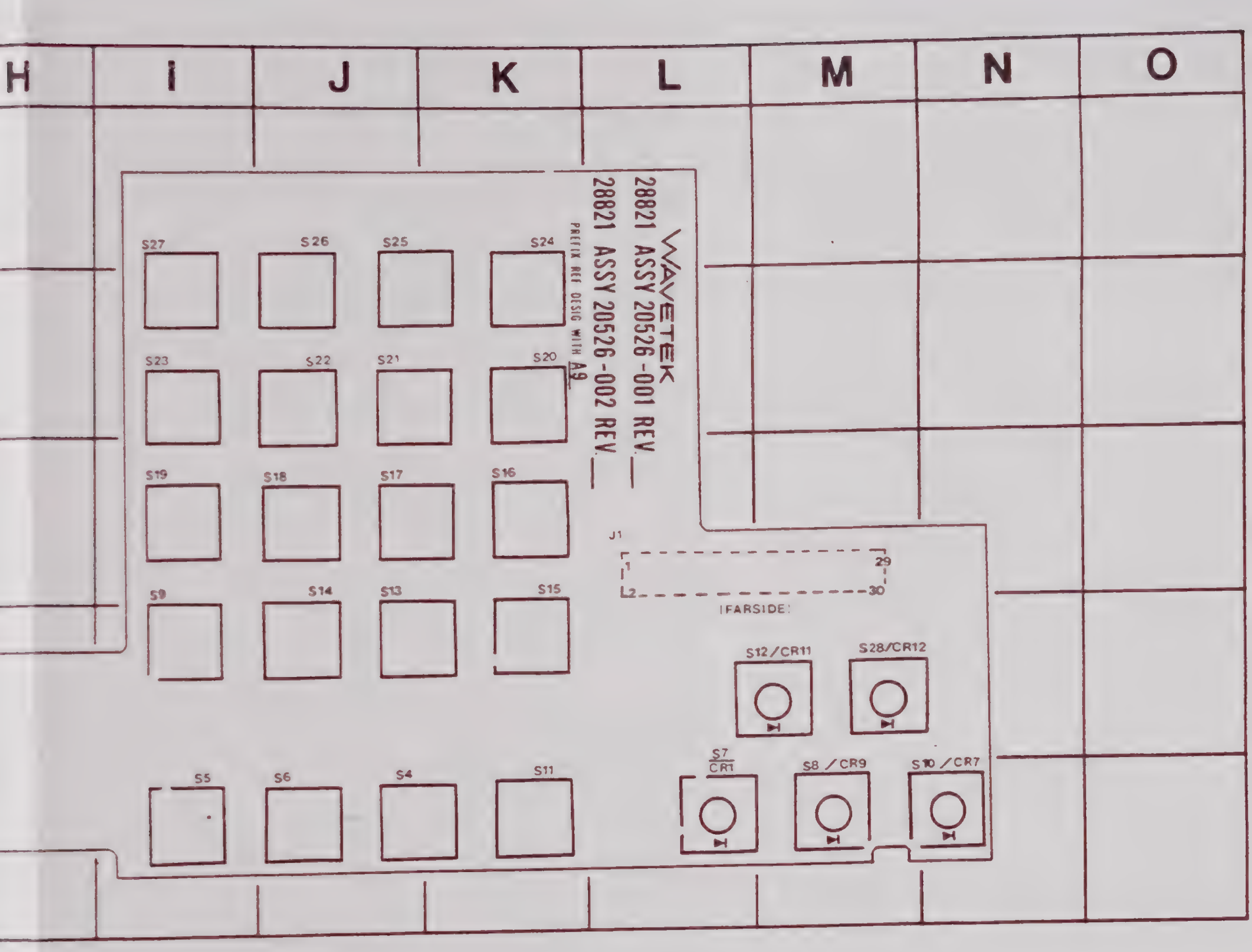
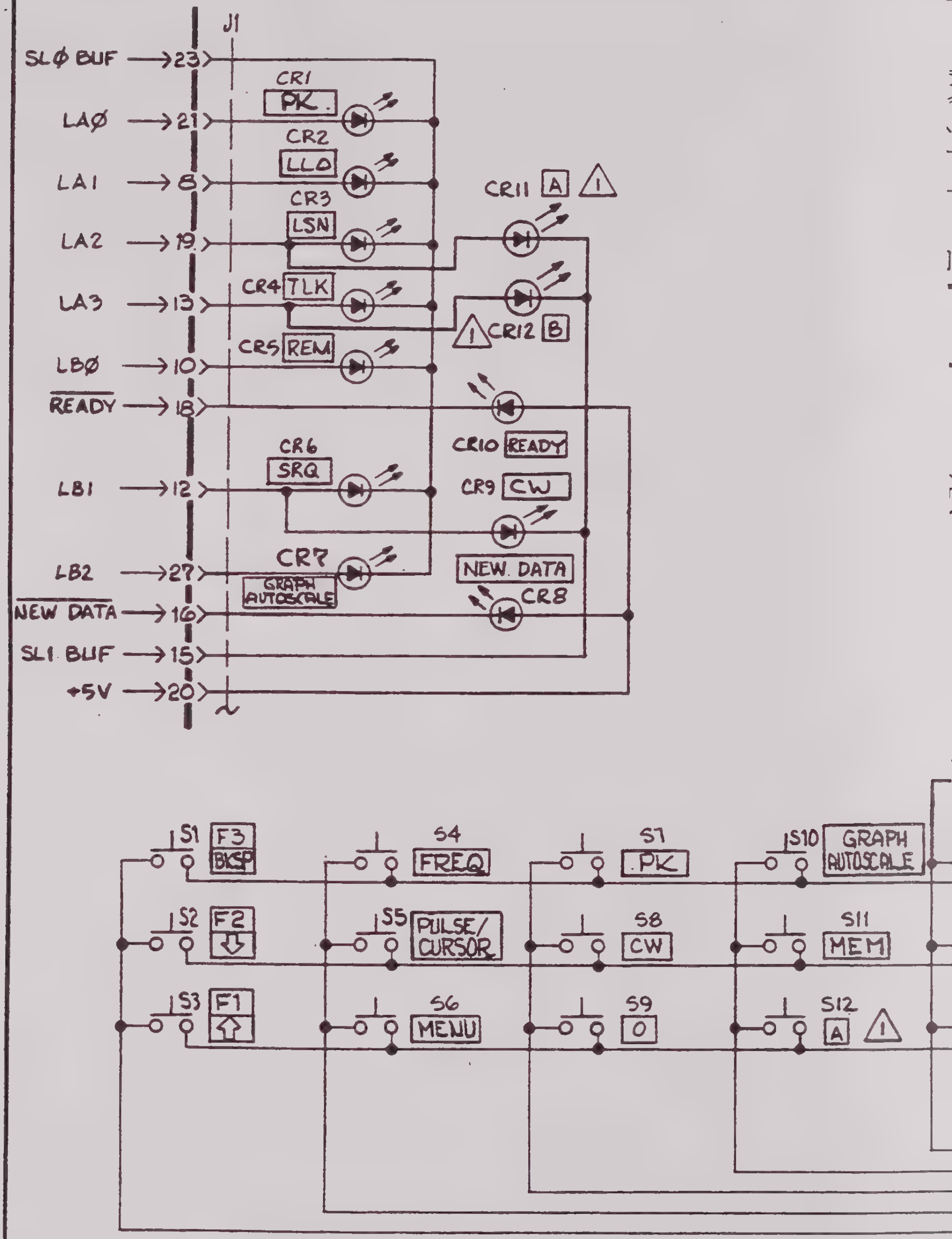

A
B
C
D
E
F
G
1
2
3
4
5
S3
S2
S1
MADE IN U.S.A.
CR2
CR3
CR4
CR5
CR6
CR10
CR8

Figure 8-8 Front Panel P

CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
CR1	L-5	J1	L-3	S11	K-5	S23	I-2
CR2	B-5			S12	M-4	S24	K-2
CR3	C-5	S1	G-4	S13	J-4	S25	J-2
CR4	C-5	S2	E-4	S14	J-4	S26	J-2
CR5	D-5	S3	C-4	S15	K-4	S27	I-2
CR6	D-5	S4	J-5	S16	K-3	S28	M-4
CR7	N-5	S5	I-5	S17	J-3		
CR8	F-5	S6	J-5	S18	J-3		
CR9	M-5	S7	L-5	S19	I-3		
CR10	F-5	S8	M-5	S20	K-2		
CR11	M-5	S9	I-4	S21	J-2		
CR12	M-5	S10	N-5	S22	J-2		


H
I
J
K
L
M
N
O
WAVETEK
28821 ASSY 20526-001 REV.__
28821 ASSY 20526-002 REV.__
PREFIX REF DESIG WITH A9
S27
S26
S25
S24
S23
S22
S21
S20
S19
S18
S17
S16
S9
S14
S13
S15
J1
1
2
29
30
(FARSIDE)
S12/CR11
S28/CR12
S7/CR1
S8/CR9
S10/CR7
S5
S6
S4
S11

CB Assembly #20526


J1
SL0 BUF 23
LA0 21
LA1 8
LA2 19
LA3 13
LB0 10
READY 18
LB1 12
LB2 27
NEW DATA 16
SL1 BUF 15
+5V 20
CR1 PK.
CR2 LLO
CR3 LSN
CR4 TLK
CR5 REM
CR6 SRQ
CR7 GRAPH AUTOSCALE
CR8 NEW. DATA
CR9 CW
CR10 READY
CR11 A 1
CR12 B 1
S1 F3 BKSP
S2 F2 ⇩
S3 F1 ⇧
S4 FREQ
S5 PULSE/ CURSOR
S6 MENU
S7 PK
S8 CW
S9 0
S10 GRAPH AUTOSCALE
S11 MEM
S12 A 1

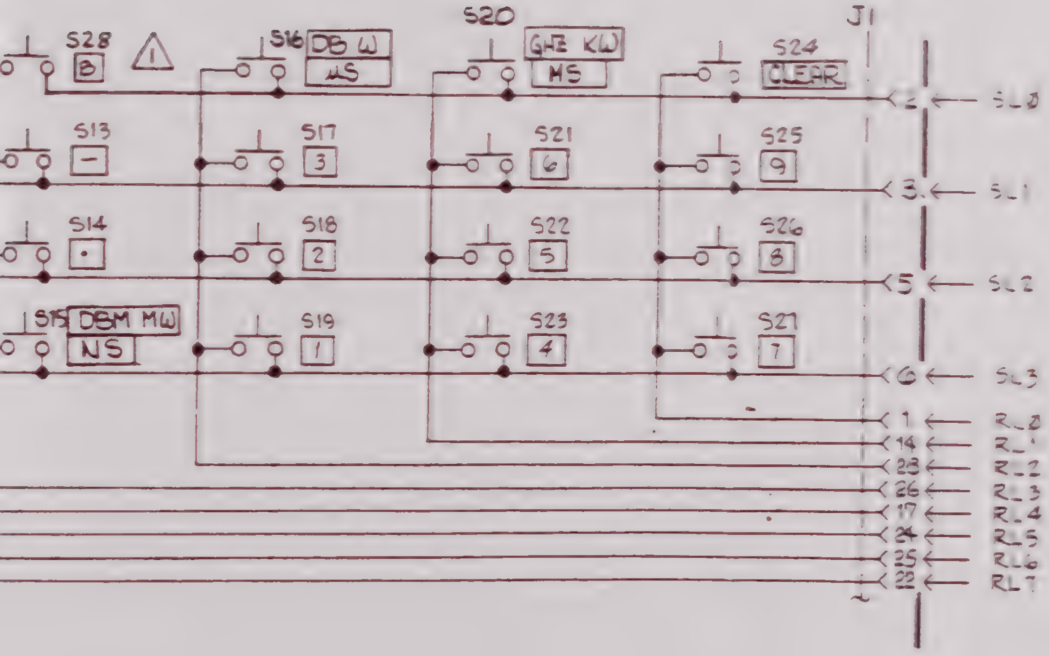
NOTES:

△1 NOT USED ON MODEL 8501A.

DIETRICH POST RECORDER NO. 82939

SYM	REVISION	ECO	DATE	APPR

8501A ASSEMBLY 20526-001
8502A ASSEMBLY 20526-002
REF. DESIG. ARE ABBREVIATED WITH PREFIX A9


S28
B
S16
DB W
µS
S20
GHz KW
MS
S24
CLEAR
J1
S13
−
S17
3
S21
6
S25
9
S14
·
S18
2
S22
5
S26
8
S15
DBM MW
NS
S19
1
S23
4
S27
7
2 ← SL0
3 ← SL1
5 ← SL2
6 ← SL3
1 ← RL0
14 ← RL1
23 ← RL2
26 ← RL3
17 ← RL4
24 ← RL5
25 ← RL6
22 ← RL7

ITEM	REQD	PART NO.	DESCRIPTION

LIST OF MATERIAL

FINISH OR TREATMENT	UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES TOLERANCE .XX = .015 .XXX = .005 ANGLE = 1/2° 63√	DRAWN Crawford	DATE 3-29-89
		CHECKED J. Baum	3-16-90
		ENG G. Oshima	3/26/90
		MFG ENG H. Kehm	4/6/90
	SCALE		

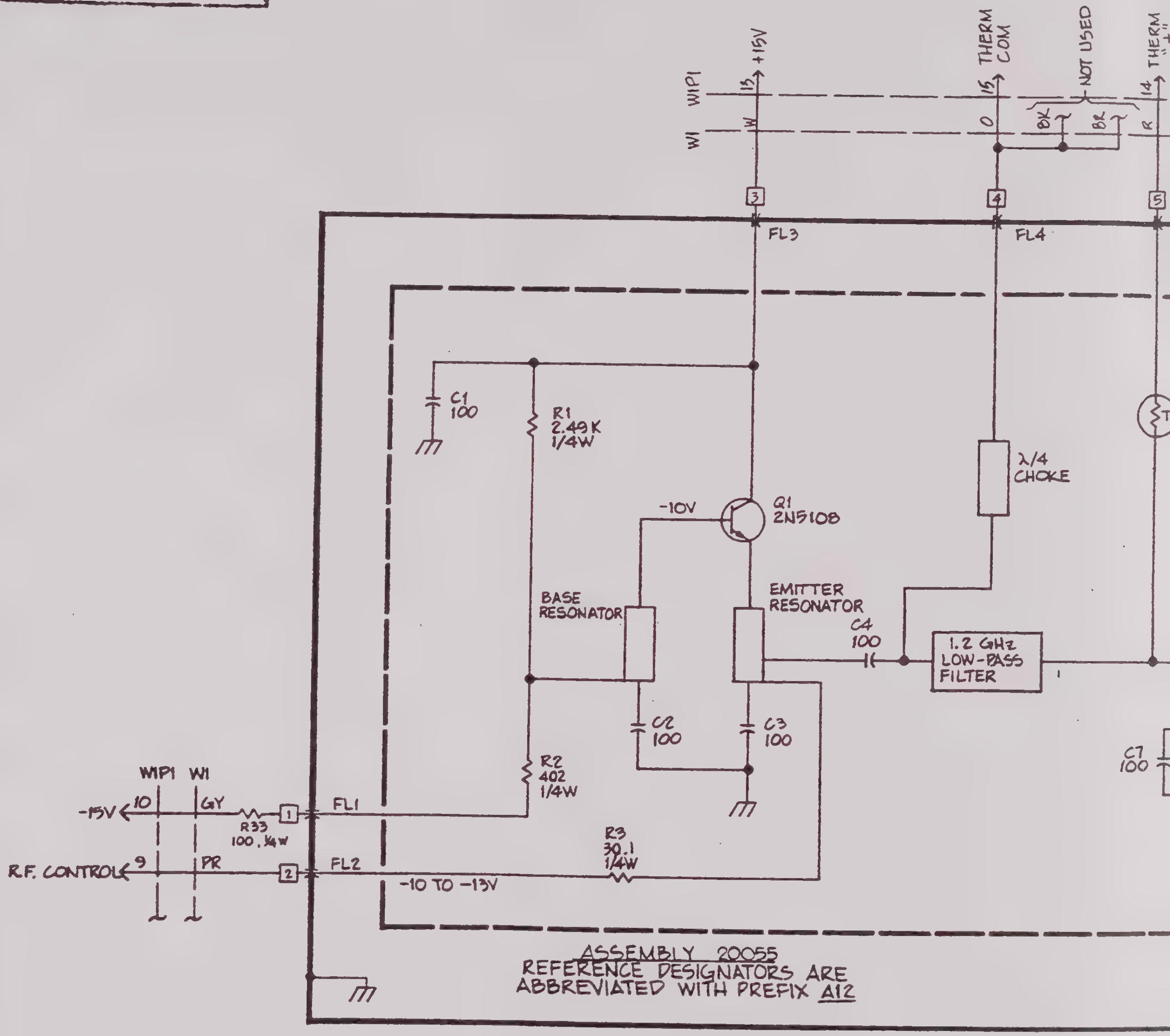
NEXT ASSY

WAVETEK PACIFIC MEASUREMENTS INC
SUNNYVALE, CALIFORNIA

FRONT PANEL

DRAWING NO. 20527
REV 1
SHEET OF

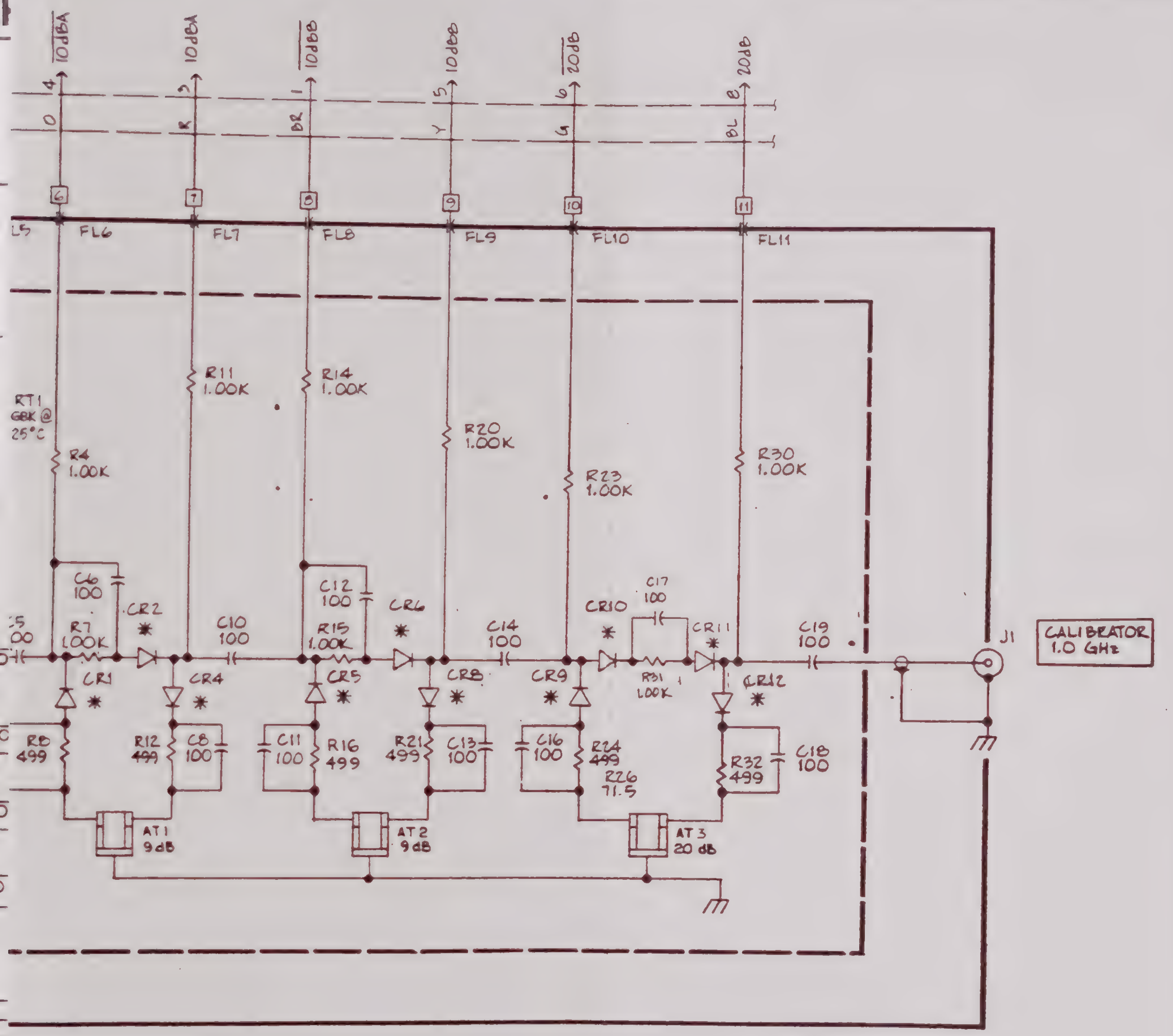
THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION AND DESIGN RIGHTS BELONGING TO WAVETEK AND MAY NOT BE REPRODUCED FOR ANY REASON EXCEPT CALIBRATION, OPERATION, AND MAINTENANCE WITHOUT WRITTEN AUTHORIZATION


W1
W1P1
13
+15V
W
15
THERM COM
0
NOT USED
BK
BR
R
14
THERM
3
4
5
FL3
FL4
C1 100
R1 2.49K 1/4W
-10V
Q1 2N5108
λ/4 CHOKE
BASE RESONATOR
EMITTER RESONATOR
C4 100
1.2 GHz LOW-PASS FILTER
C2 100
C3 100
C7 100
R2 402 1/4W
W1P1 W1
-15V
10
GY
R33 100, ¼W
1
FL1
R.F. CONTROL
9
PR
2
FL2
R3 30.1 1/4W
-10 TO -13V
ASSEMBLY 20055
REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A12

NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS, ± 1%, 1/8 WATT AND CAPACITORS ARE IN PICOFARADS.
2. ✱ R.F. SWITCH DIODE.

SYM	REVISION	ECO	DATE	APPD



4 10dBA
3 10dBA
1 10dBB
5 10dBB
6 20dB
8 20dB
O
R
BR
Y
G
BL
6
7
8
9
10
11
L5
FL6
FL7
FL8
FL9
FL10
FL11
RT1
68K @
25°C
R4
1.00K
R11
1.00K
R14
1.00K
R20
1.00K
R23
1.00K
R30
1.00K
C6
100
C12
100
C17
100
CR2
CR6
CR10
CR11
C5
100
R7
1.00K
C10
100
R15
1.00K
C14
100
R31
1.00K
C19
100
J1
CALIBRATOR
1.0 GHz
CR1
CR4
CR5
CR8
CR9
CR12
R8
499
R12
499
C8
100
C11
100
R16
499
R21
499
C13
100
C16
100
R24
499
R26
71.5
R32
499
C18
100
AT1
9dB
AT2
9dB
AT3
20 dB

DRAWN C. SCHMID	DATE 6-21-85	WAVETEK PACIFIC MEASUREMENTS INC. SUNNYVALE, CALIFORNIA
CHECKED	10-29-85	CALIBRATOR, 1 GHz
ENG RB	10 30 85	
MFG ENG WF	11-8-85	DRAWING NO. 17097 REV K
QA		SHEET 1 OF 1

CHAPTER 9

REPLACEABLE PARTS LISTINGS

Description ... Page No.

Mainframe Assembly #20512 (Model 8501A) ... 9-2

Mainframe Assembly #20513 (Model 8502A) ... 9-2

Interconnect PC Board Assembly #16932-001 (Board #A1) ... 9-3

Power Supply PC Board Assembly #16995 (Board #A2) ... 9-5

GPIB/CAL Control PC Board Assembly #21014 (Board #A3) ... 9-7

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Digital Delay PC Board Assembly #16658 (Board #A5) ... 9-13

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1GHz Calibrator Assembly #20055-002 (Same as -001, only with APC-7 Connector)

8501A - PEAK POWER METER #20512

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A1	16932-001	PCB ASSY, INTERCONNECT	VELONEX	WMI 16932-001
A2	16995	PCB ASSY, POWER SUPPLY	WAVETEK MICROWAVE	16995
A3	21014	PCB ASSY, GPIB/CAL CONTROL	WAVETEK MICROWAVE	21014
A4	16878	PCB ASSY, CPU	WAVETEK MICROWAVE	16878
A5	16685	PCB ASSY, DIGITAL DELAY	WAVETEK MICROWAVE	16685
A6	20741	PCB ASSY, ANALOG	WAVETEK MICROWAVE	WMI 20741
A8	20195	PCB ASSY, FR PNL INTERFACE	WAVETEK MICROWAVE	WMI 20195
A9	20526-001	PCB ASSY, FRONT PANEL	WAVETEK MICROWAVE	WMI 20526-001
A12	20055-001	ASSY, 1GHZ CALIBRATOR TYPE N	WAVETEK MICROWAVE	20055-001
B2	21100	STEPPER MOTOR ASSY	WAVETEK MICROWAVE	PER WMI 21100
C1	11573-001	CAP MIN CER .001MF 20% 50VDC	WESTCAP	G504BX102M
CR1	15775	BRIDGE RECTIFIER 10A 100PRV	GENERAL INSTRUMENTS	KBPCA0-04
F1	15058-001	FUSE, SLO BLO 2A 250V	LITTLEFUSE	313 002

NOTE: Fuse is 2A for 110/220 V operations, or 1A for 220/240 V operations.

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
J1	16364	CONN VOLT SELEC S FUSED FILTER	CORCOM	6J4
J2	10048	CONN CO-AX UG1094/U BNC RECEPT	AMPHENOL	31-221
J3	11689	CONN BNC JACK W/ISOL. GROUND	KINGS	KC-79-67
J4	10048	CONN CO-AX UG1094/U BNC RECEPT	AMPHENOL	31-221
J6	10048	CONN CO-AX UG1094/U BNC RECEPT	AMPHENOL	31-221
J7	10048	CONN CO-AX UG1094/U BNC RECEPT	AMPHENOL	31-221
LS1	17042	SPEAKER, 2 INCH SQ	MOUSER ELECTRONICS	25SP003
R2	11676-006	RES VAR 100 OHM 20% 1/2W	ALLEN-BRADLEY CO.	WA1NO24S101MZ
S1	13260	SWITCH PUSHBUTTON POWER	TARGET ELECTRONICS	001399
T1	16762	TRANSFORMER PWR	TOKIN MAGNETICS, INC.	PER WMI PRINT
W1	17051	CABLE ASSY, DETECTOR INPUT	WAVETEK MICROWAVE	17051
W2	17280	FAN ASSY	WAVETEK MICROWAVE	17280
W3	17131	CABLE ASSY, 8500 REAR PANEL	WAVETEK MICROWAVE	17131
W4	20570	CABLE ASSY, FR PANEL-INTCON	WAVETEK MICROWAVE	PER WMI DWG
W7	17056	CABLE ASSY, SPEAKER	WAVETEK MICROWAVE	17056
W8	20721	CABLE ASSY, EL DSPL-FP INTFC	DE ANZA MFG. SERVICES	PER WMI PRINT
W9	17091-001	CABLE ASSY, W9 W-R DISC	WAVETEK MICROWAVE	17091-001
W10	17163-001	CABLE ASSY, W-PR DISC	WAVETEK MICROWAVE	17163-001
W11	17259-001	CABLE ASSY, BNC TO SMC RG178B/U	WAVETEK MICROWAVE	17259-001

8502A - PEAK POWER METER #20513

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A1	16932-001	PCB ASSY, INTERCONNECT	VELONEX	WMI 16932-001
A2	16995	PCB ASSY, POWER SUPPLY	WAVETEK MICROWAVE	16995
A3	21014	PCB ASSY, GPIB/CAL CONTROL	WAVETEK MICROWAVE	21014
A4	16878	PCB ASSY, CPU	WAVETEK MICROWAVE	16878
A5	16685	PCB ASSY, DIGITAL DELAY	WAVETEK MICROWAVE	16685
A6	20741	PCB ASSY, ANALOG	WAVETEK MICROWAVE	WMI 20741
A7	20741	PCB ASSY, ANALOG	WAVETEK MICROWAVE	WMI 20741

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A8	20195	PCB ASSY, FR PNL INTERFACE	WAVETEK MICROWAVE	WMI 20195
A9	20526-002	PCB ASSY, FRONT PANEL	WAVETEK MICROWAVE	WMI 20526-0
A12	20055-001	ASSY, 1GHZ CALIBRATOR TYPE N	WAVETEK MICROWAVE	20055-001
B2	21100	STEPPER MOTOR ASSY	WAVETEK MICROWAVE	PER WMI 21100
C1	11573-001	CAP MIN CER .001MF 20% 50VDC	WESTCAP	G504BX102M
C2	11573-001	CAP MIN CER .001MF 20% 50VDC	WESTCAP	G504BX102M
CR1	15775	BRIDGE RECTIFIER 10A 100PRV	GENERAL INSTRUMENTS	KBPCA0-04
F1	15058-001	FUSE, SLO BLO 2A 250V	LITTLEFUSE	313 002

NOTE: Fuse is 2A for 110/220 V operations, or 1A for 220/240 V operations.

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
J1	16364	CONN VOLT SELEC $ FUSED FILTER	CORCOM	6J4
J2	10048	CONN CO-AX UG1094/U BNC RECEPT	AMPHENOL	31-221
J3	11689	CONN BNC JACK W/ISOL. GROUND	KINGS	KC-79-67
J4	10048	CONN CO-AX UG1094/U BNC RECEPT	AMPHENOL	31-221
J6	10048	CONN CO-AX UG1094/U BNC RECEPT	AMPHENOL	31-221
J7	10048	CONN CO-AX UG1094/U BNC RECEPT	AMPHENOL	31-221
J8	10048	CONN CO-AX UG1094/U BNC RECEPT	AMPHENOL	31-221
J9	10048	CONN CO-AX UG1094/U BNC RECEPT	AMPHENOL	31-221
LS1	17042	SPEAKER, 2 INCH SQ	MOUSER ELECTRONICS	25SP003
R2	11676-006	RES VAR 100 OHM 20% 1/2W	ALLEN-BRADLEY CO.	WA1NO24S101MZ
S1	13260	SWITCH PUSHBUTTON POWER	TARGET ELECTRONICS	001399
T1	16762	TRANSFORMER PWR	TOKIN MAGNETICS, INC.	PER WMI PRINT
W1	17051	CABLE ASSY, DETECTOR INPUT	WAVETEK MICROWAVE	17051
W2	17280	FAN ASSY	WAVETEK MICROWAVE	17280
W3	17131	CABLE ASSY, 8500 REAR PANEL	WAVETEK MICROWAVE	17131
W4	20570	CABLE ASSY, FR PANEL-INTCON	WAVETEK MICROWAVE	PER WMI D
W7	17056	CABLE ASSY, SPEAKER	WAVETEK MICROWAVE	17056
W8	20721	CABLE ASSY, EL DSPL-FP INTFC	DE ANZA MFG. SERVICES	PER WMI PR
W9	17091-001	CABLE ASSY, W9 W-R DISC	WAVETEK MICROWAVE	17091-001
W10	17163-001	CABLE ASSY, W-PR DISC	WAVETEK MICROWAVE	17163-001
W11	17259-001	CABLE ASSY, BNC TO SMC RG178B/U	WAVETEK MICROWAVE	17259-001
W12	17051	CABLE ASSY, DETECTOR INPUT	WAVETEK MICROWAVE	17051

INTERCONNECT PCB ASSY #16932-001

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A1C1	10238-005	CAP ELECT 24000 MFD 10V-10+75%	MALLORY	CGS 243U015 R3C3PH
A1C2	10238-003	CAP ELECTROLYTIC 42500MFD 15V	MALLORY	CGS 503 U015V3C3PH
A1C3	10238-006	CAPACITOR,ELECT	CONNECTING DEVICES INC	FAH-4900-30-A2
A1C4	10238-006	CAPACITOR,ELECT	CONNECTING DEVICES INC	FAH-4900-30-A2
A1C5	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A1C6	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A1C7	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A1C8	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A1C9	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A1C10	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A1C11	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A1C12	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A1C13	10003-007	CAP ELE 1000MF 35WVDC +50-10%	SIEMENS	B41010-1000\40\8212
A1C14	10003-007	CAP ELE 1000MF 35WVDC +50-10%	SIEMENS	B41010-1000\40\8212
A1C15	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A1C16	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A1C17	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A1CR1	12409	RECTIFIER FULL WAVE BRIDGE	ELECTRONIC DEVICES, INC.	PE10
A1CR2	10045	DIODE 1N823 ZENER REF 6.2V 5%	SIEMENS	IN823
A1J1	17002-001	CONN PCB .100X36/72 POS	SULLEN ELECTRONIC	EZC36DRSI
A1J2	17002-001	CONN PCB .100X36/72 POS	SULLEN ELECTRONIC	EZC36DRSI
A1J3	17002-001	CONN PCB .100X36/72 POS	SULLEN ELECTRONIC	EZC36DRSI
A1J4	17002-001	CONN PCB .100X36/72 POS	SULLEN ELECTRONIC	EZC36DRSI
A1J5	17002-001	CONN PCB .100X36/72 POS	SULLEN ELECTRONIC	EZC36DRSI
A1J6	17002-001	CONN PCB .100X36/72 POS	SULLEN ELECTRONIC	EZC36DRSI
A1J7	17002-001	CONN PCB .100X36/72 POS	SULLEN ELECTRONIC	EZC36DRSI
A1J8	17002-001	CONN PCB .100X36/72 POS	SULLEN ELECTRONIC	EZC36DRSI
A1J9	17002-001	CONN PCB .100X36/72 POS	SULLEN ELECTRONIC	EZC36DRSI
A1J10	17002-001	CONN PCB .100X36/72 POS	SULLEN ELECTRONIC	EZC36DRSI
A1J11	17002-001	CONN PCB .100X36/72 POS	SULLEN ELECTRONIC	EZC36DRSI
A1J12	17002-001	CONN PCB .100X36/72 POS	SULLEN ELECTRONIC	EZC36DRSI
A1J13	14664-001	CONN R-ANGLE PCB-PNL 24 STD	AMP, INC	552791-1
A1J19	14654	TAB CONN. QUICK DISCONNECT	KEYSTONE MFG	1287
A1J20	14654	TAB CONN. QUICK DISCONNECT	KEYSTONE MFG	1287
A1J21	14654	TAB CONN. QUICK DISCONNECT	KEYSTONE MFG	1287
A1J22	14654	TAB CONN. QUICK DISCONNECT	KEYSTONE MFG	1287
A1J23	14654	TAB CONN. QUICK DISCONNECT	KEYSTONE MFG	1287
A1J24	14654	TAB CONN. QUICK DISCONNECT	KEYSTONE MFG	1287
A1J25	15112	CONN, SMB COAXIAL, PC MNT	CABLEWAVE	700214
A1J26	15112	CONN, SMB COAXIAL, PC MNT	CABLEWAVE	700214
A1J27	20724	CONN BNC PCB MOUNT	AMP, INC.	227699-3
A1J28	20724	CONN BNC PCB MOUNT	AMP, INC.	227699-3
A1J29	20724	CONN BNC PCB MOUNT	AMP, INC.	227699-3
A1J30	20724	CONN BNC PCB MOUNT	AMP, INC.	227699-3
A1J37	13271	COUPLING STRAIGHT JACK	M/A-COM OMNI SPECTRA, INC	700209
A1R1	10241-008	RES.CARB.COMP.,5.6 OHM,1\2W	T.T.I.	RC20GF5R6J
A1R2	10241-008	RES.CARB.COMP.,5.6 OHM,1\2W	T.T.I.	RC20GF5R6J
A1R3	10241-008	RES.CARB.COMP.,5.6 OHM,1\2W	T.T.I.	RC20GF5R6J
A1R4	10241-008	RES.CARB.COMP.,5.6 OHM,1\2W	T.T.I	RC20GF5R6J
A1R5	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A1R6	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A1RP2	14882-001	RES NETWK 10K OHM 2% 125MW	ALLEN-BRADLEY CO.	110A103
A1RP3	14882-001	RES NETWK 10K OHM 2% 125MW	ALLEN-BRADLEY CO.	110A103
A1S1	17025	SWITCH SPST PB MOMENTARY PC MT	ALCO SWITCH	TPB11CG-RA-0
A1W1	20119-001	JUMPER, INSULATED .500 LEAD SP	MC KENZIE TECHNOLOGY	JO .500 X 0.125-PVC-24
A1W5	20119-001	JUMPER, INSULATED .500 LEAD SP	MC KENZIE TECHNOLOGY	JO .500 X 0.125-PVC-24
A1W6	20119-001	JUMPER, INSULATED .500 LEAD SP	MC KENZIE TECHNOLOGY	JO .500 X 0.125-PVC-24

PCB ASSY, POWER SUPPLY PCB ASSY #16995

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A2C1	10000-002	CAP CER 220PF 20% 1000VDC	SPRAGUE ELECTRIC CO.	5GA-T22
A2C2	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A2C3	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A2C4	10787-004	CAP TANTALUM 68MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D686X0025TE4
A2C5	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A2C6	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A2C7	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A2C8	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A2C9	10787-004	CAP TANTALUM 68MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D686X0025TE4
A2C10	10787-004	CAP TANTALUM 68MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D686X0025TE4
A2C11	10787-004	CAP TANTALUM 68MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D686X0025TE4
A2C12	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A2C13	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A2C14	10001-007	CAP CER 100PF 5% 1000VDC	SPRAGUE ELECTRIC CO.	10TCC-T10
A2C15	10787-004	CAP TANTALUM 68MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D686X0025TE4
A2C16	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A2C17	10001-007	CAP CER 100PF 5% 1000VDC	SPRAGUE ELECTRIC CO.	10TCC-T10
A2C18	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A2C19	10787-004	CAP TANTALUM 68MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D686X0025TE4
A2C21	10003-005	CAP ELE 100MF 35 WVDC +50 -10%	SIEMENS	B41283-100\40\8118
A2C22	10787-005	CAP TANTALUM 1MF 20% 15VDC	SPRAGUE ELECTRIC CO.	196D105X0035HA1
A2C23	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A2CR1	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A2CR2	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A2CR3	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A2CR4	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A2CR5	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A2CR6	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A2CR7	10045	DIODE 1N823 ZENER REF 6.2V 5%	SIEMENS	IN823
A2CR8	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A2CR9	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A2CR10	10044-001	DIODE 1N4383	DIODES INCORPORATED	J2
A2CR11	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A2CR12	10044-001	DIODE 1N4383	DIODES INCORPORATED	J2
A2CR14	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A2CR15	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A2CR19	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A2CR20	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A2CR21	11868	DIODE SILICON ZENER	MOTOROLA (SPD)	IN5229B
A2CR22	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A2CR23	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A2F1	10064-013	FUSE 3AG STD 10 AMP 125V	LITTLEFUSE	312-010
A2F2	10064-013	FUSE 3AG STD 10 AMP 125V	LITTLEFUSE	312-010
A2Q1	14623	TRANSISTOR PNP 2N6489	RCA	2N6489
A2Q2	10206	TRANSISTOR 2N3053	NATIONAL SEMICONDUCTOR	2N3053
A2Q3	10927	TRANSISTOR 2N4314	RCA	2N4314
A2Q4	14622	TRANSISTOR NPN 2N6486	MOTOROLA (SPD)	2N6486
A2Q5	14623	TRANSISTOR PNP 2N6489	RCA	2N6489

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A2Q6	10019	TRANSISTOR 2N3565	NATIONAL SEMICONDUCTOR	2N3565
A2Q7	10927	TRANSISTOR 2N4314	RCA	2N4314
A2Q8	11119	TRANSISTOR 2N4250	NATIONAL SEMICONDUCTOR	2N4250
A2Q9	10206	TRANSISTOR 2N3053	NATIONAL SEMICONDUCTOR	2N3053
A2Q10	14622	TRANSISTOR NPN 2N6486	MOTOROLA (SPD)	2N6486
A2R1	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A2R2	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A2R3	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A2R6	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A2R7	12449-051	RES MF 2.000K OHM 0.1% 1/8W	DALE ELECTRONICS	MFF 1/8 T2
A2R8	10633-002	RES MET OX .24 OHM 5% 1W	KOA SPEER ELECTRONICS, IN	M01R24J
A2R9	12449-037	RES MF 20.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A2R10	12449-075	RES MF 1.745K OHM 0.1% 1/8W	DALE ELECTRONICS	MFF 1/8 T2 1.745K OHM.1%
A2R11	12449-037	RES MF 20.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A2R12	10665-003	RES CARB COMP 100 OHM 10% 1W	TRW IRC RESISTORS	RCR32GF101J
A2R13	10665-003	RES CARB COMP 100 OHM 10% 1W	TRW IRC RESISTORS	RCR32GF101J
A2R14	10013-029	RES DEP CARB 2.2K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A2R15	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A2R16	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A2R17	10015-065	RES MET FILM 4.99K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 4.99K OHM 1%
A2R18	10015-084	RES MET FILM 2.10K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 2.10K OHM 1%
A2R19	10013-061	RES DEP CARB 1M OHM 5% 1/4W	MEPCO/ELECTRA	B803 104NB 105
A2R20	10015-020	RES MET FILM 1.10K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 1.10K OHM 1%
A2R21	10015-176	RES MET FILM 3.48K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 3.48K OHM 1%
A2R22	15142-004	RES VAR CERM 500 OHM 10% 1/2W	BECKMAN	66XR500
A2R23	10015-065	RES MET FILM 4.99K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 4.99K OHM 1%
A2R24	12449-074	RES MF 1.182K OHM 0.1% 1/8W	DALE ELECTRONICS	MFF 1/8 T2 1.182K OHM.1%
A2R25	10633-002	RES MET OX .24 OHM 5% 1W	KOA SPEER ELECTRONICS, IN	M01R24J
A2R26	12449-037	RES MF 20.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A2R27	12449-037	RES MF 20.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A2R28	12449-019	RES MF 1.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A2R29	14935-001	RES WIREWOUND 0.1 OHM 10% 4W	DALE ELECTRONICS	RW67VR10
A2R31	10015-222	RES MET FILM 8.25K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 8.25K OHM 1%
A2R32	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A2R33	12449-030	RES MF 30.0K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A2R34	10015-019	RES MET FILM 1.0K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 1K OHM 1%
A2R35	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A2R36	10015-179	RES MET FILM 140K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 140K OHM 1%
A2R37	10013-033	RES DEP CARB 4.7K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A2R38	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A2R39	11845-004	RES MTL GLAZE 15 OHM 10% 2W	CORNING GLASS WORKS	FP-2
A2R40	10013-033	RES DEP CARB 4.7K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A2R41	10015-035	RES MET FILM 1.78K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 1.78K OHM 1%
A2R42	15142-005	RES VAR CERM 5K OHM 10% 1/2W	BECKMAN	66XR5K
A2R43	10015-028	RES MET FILM 23.7K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 23.7K 1%
A2R44	10015-133	RES MET FILM 49.9K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 49.9K OHM 1%
A2R45	10015-211	RES MET FILM 2.74K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 2.74K OHM 1%
A2R47	14935-001	RES WIREWOUND 0.1 OHM 10% 4W	DALE ELECTRONICS	RW67VR10
A2R48	10015-019	RES MET FILM 1.0K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 1K OHM 1%
A2R49	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A2R50	11845-004	RES MTL GLAZE 15 OHM 10% 2W	CORNING GLASS WORKS	FP-2
A2R51	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A2R53	10015-207	RES MET FILM 20.0K OHM 1% 1/8W	CORNING GLASS WORKS	20K OHM 1%
A2R55	10013-033	RES DEP CARB 4.7K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A2R57	10015-007	RES MET FILM 10.0K OHM 1% 1/8W	LARTRONICS, INC.	10.0K OHM 1% 1/8W
A2R59	10015-059	RES MET FILM 10.5K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 10.5K OHM 1%
A2R60	10015-032	RES MET FILM 3.83K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 3.83K OHM 1%
A2R61	10013-001	RES DEP CARB 10 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A2R64	10013-033	RES DEP CARB 4.7K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A2R65	10013-029	RES DEP CARB 2.2K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A2R66	10013-012	RES DEP CARB 82 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A2R67	10015-116	RES MET FILM 30.1K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 30.1K OHM 1%
A2R68	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A2S1	17185	SCD, SWITCH, THERMAL	ELMWOOD SENSORS, INC.	PER SCD (B) 17185
A2TP1	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A2TP2	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A2TP3	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A2TP4	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A2TP5	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A2TP6	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A2TP7	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A2TP8	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A2TP9	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A2TP10	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A2TP11	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A2U1	13471	INTEGRATED CKT LM324N	SGS	LM324AN
A2U2	14621	INTEGRATED CKT LM358N	NATIONAL SEMICONDUCTOR	LM358N
A2U3	14621	INTEGRATED CKT LM358N	NATIONAL SEMICONDUCTOR	LM358N
A2U4	15491	LINEAR IC, DUAL COMPARATOR	NATIONAL SEMICONDUCTOR	LM393N
A2U5	17713	I.C. LM385BZ1.2	NATIONAL SEMICONDUCTOR	LM385BZ1.2

GPIB/CAL CONTROL PCB ASSY #21014

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A3C6	10001-005	CAP CER 33PF 5% 1000VDC	SPRAGUE ELECTRIC CO.	10TCC-Q33
A3C7	10787-001	CAP TANTALUM 4.7MF 20% 35VDC	SPRAGUE ELECTRIC CO.	199D475X9035CA2
A3C8	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C9	15776-010	CAP, CER .22UF 10% 50V	PHILLIPS/CENTRALAB	CW30C224K
A3C10	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C11	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C12	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A3C13	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C15	15776-028	CAP CER 100PF 10% 50V	PHILLIPS/CENTRALAB	CW20C101K
A3C16	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C17	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C18	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C19	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C20	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A3C21	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C22	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C23	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C24	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C25	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C26	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C27	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C28	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C29	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C30	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C31	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C34	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C35	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C36	10787-002	CAP TANTALUM 12MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D126X9020JA1
A3C37	10787-002	CAP TANTALUM 12MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D126X9020JA1
A3C38	10787-002	CAP TANTALUM 12MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D126X9020JA1
A3C44	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C47	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C49	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A3C50	15776-004	CAP,CER .0022 MFD 10% 50V	PHILLIPS/CENTRALAB	CW15C222K
A3C56	15776-004	CAP,CER .0022 MFD 10% 50V	PHILLIPS/CENTRALAB	CW15C222K
A3C57	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A3CR1	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A3CR2	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A3CR3	11715	DIODE SILICON 1N4446	NATIONAL SEMICONDUCTOR	1N4446
A3CR4	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A3CR5	10044-001	DIODE 1N4383	DIODES INCORPORATED	J2
A3CR6	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A3CR7	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A3Q1	10017	TRANSISTOR 2N3569	NATIONAL SEMICONDUCTOR	2N3569
A3Q2	10023	TRANSISTOR 2N3644	NATIONAL SEMICONDUCTOR	2N3644
A3Q3	10017	TRANSISTOR 2N3569	NATIONAL SEMICONDUCTOR	2N3569
A3Q4	10023	TRANSISTOR 2N3644	NATIONAL SEMICONDUCTOR	2N3644
A3Q5	10017	TRANSISTOR 2N3569	NATIONAL SEMICONDUCTOR	2N3569
A3Q6	10023	TRANSISTOR 2N3644	NATIONAL SEMICONDUCTOR	2N3644
A3Q7	10017	TRANSISTOR 2N3569	NATIONAL SEMICONDUCTOR	2N3569
A3Q8	13903	TRANSISTOR POWER TIP 29	TEXAS INSTRUMENTS	TIP29
A3Q10	10019	TRANSISTOR 2N3565	NATIONAL SEMICONDUCTOR	2N3565
A3Q11	10023	TRANSISTOR 2N3644	NATIONAL SEMICONDUCTOR	2N3644
A3Q13	10023	TRANSISTOR 2N3644	NATIONAL SEMICONDUCTOR	2N3644
A3R1	10013-038	RES CARB FILM 12K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R2	10013-038	RES CARB FILM 12K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R3	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R4	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R12	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A3R13	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R14	10013-045	RES DEP CARB 47K OHM 5% 1/4W	MEPCO/ELECTRA	CR25 47K 5%
A3R15	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A3R16	15142-005	RES VAR CERM 5K OHM 10% 1/2W	BECKMAN	66XR5K
A3R17	10013-033	RES DEP CARB 4.7K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A3R18	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A3R19	10015-301	RES MET FILM 845 OHM 1% 1/8W	CORNING GLASS WORKS	RM55D 8450F
A3R20	10015-019	RES MET FILM 1.0K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 1K OHM 1%
A3R21	10015-174	RES MET FILM 1.62K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 1.62K OHM 1%
A3R22	10013-057	RES DEP CARB 470K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R28	10015-104	RES MET FILM 5.62K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 5.62K OHM 1%
A3R29	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R38	12449-033	RES MF 100K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A3R39	12449-033	RES MF 100K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A3R40	12449-033	RES MF 100K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A3R41	12449-033	RES MF 100K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A3R42	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R44	10013-029	RES DEP CARB 2.2K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R45	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R46	10013-031	RES DEP CARB 3.3K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R47	10015-098	RES MET FILM 13.3K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 13.3K OHM 1%
A3R48	10015-098	RES MET FILM 13.3K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 13.3K OHM 1%
A3R49	10015-142	RES MET FILM 40.2 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 40.2 OHM 1% 1/8W
A3R50	10013-031	RES DEP CARB 3.3K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R51	10015-098	RES MET FILM 13.3K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 13.3K OHM 1%
A3R52	10015-098	RES MET FILM 13.3K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 13.3K OHM 1%
A3R60	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A3R61	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A3R62	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A3R63	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A3R64	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A3R65	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A3R66	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A3R67	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A3R68	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A3R69	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A3R72	10013-041	RES DEP CARB 22K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R74	10015-065	RES MET FILM 4.99K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 4.99K OHM 1%
A3R75	10013-033	RES DEP CARB 4.7K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R77	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R78	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R79	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R86	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R87	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R88	10013-053	RES DEP CARB 220K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R90	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R91	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R92	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R93	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R94	10013-031	RES DEP CARB 3.3K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R95	10013-041	RES DEP CARB 22K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R96	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A3R97	10015-065	RES MET FILM 4.99K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 4.99K OHM 1%
A3R98	10015-133	RES MET FILM 49.9K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 49.9K OHM 1%
A3R113	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A3R114	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A3R115	10015-065	RES MET FILM 4.99K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 4.99K OHM 1%
A3R116	10015-019	RES MET FILM 1.0K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 1K OHM 1%
A3R117	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A3R118	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A3R119	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A3R120	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A3RP1	14882-001	RES NETWK 10K OHM 2% 125MW	ALLEN-BRADLEY CO	110A103
A3RP2	14882-001	RES NETWK 10K OHM 2% 125MW	ALLEN-BRADLEY CO	110A103
A3TP1	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A3TP2	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A3TP3	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A3TP4	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A3TP5	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A3TP6	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A3TP7	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A3TP8	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A3TP9	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A3U1	17114	IC, GPIB CONTROLLER	TEXAS INSTRUMENTS	TMS9914ANL
A3U2	17113-002	IC, OCTAL GPIB XCVR	TEXAS INSTRUMENTS	SN75162AN
A3U3	13470-047	INTEGRATED CKT SN74LS32N	TEXAS INSTRUMENTS	SN74LS32N
A3U4	17113-001	IC, OCTAL GPIB XCVR	TEXAS INSTRUMENTS	SN75160AN
A3U5	21012	IC, PROGRAMMABLE SND GEN	GENERAL INSTRUMENTS	AY-3-8912A
A3U6	13470-001	INTEGRATED CKT SN74LS00N	TEXAS INSTRUMENTS	SN74LS00N
A3U7	13470-013	INTEGRATED CKT SN74LS74N	TEXAS INSTRUMENTS	SN74LS74N
A3U8	14641	INTEGRATED CKT 8255	HARRIS CORP	CP82C55A
A3U9	14641	INTEGRATED CKT 8255	HARRIS CORP	CP82C55A
A3U10	17035	I.C. - DIGITAL TTL	ANALOG DEVICES	AD7534JN
A3U11	13471	INTEGRATED CKT LM324N	SGS	LM324AN
A3U12	13471	INTEGRATED CKT LM324N	SGS	LM324AN
A3U13	15135	INTEGRATED CKT HA7-5135-5	PRECISION MONOLITHICS	OP-07/CP
A3U14	15135	INTEGRATED CKT HA7-5135-5	PRECISION MONOLITHICS	OP-07/CP
A3U15	14634	INTEGRATED CKT, LM311N	NATIONAL SEMICONDUCTOR	LM311N
A3U16	15135	INTEGRATED CKT HA7-5135-5	PRECISION MONOLITHICS	OP-07/CP
A3U17	15119	INTEGRATED CKT DG201CJ	SILICONIX	DG201ACJ
A3U18	19490	INTEGRATED CKT MC34074	MOTOROLA (SPD)	MC34074P

CPU PCB ASSY #16878

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A4BT1	19972	BATTERY, LITHIUM AA 3.5V 1.8Ah	SAFT ADV BATTERY SYSTEM	DLS6-BA
A4C1	10787-002	CAP TANTALUM 12MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D126X9020JA1
A4C2	10000-006	CAP CER .0047MF 20% 500VDC	SPRAGUE ELECTRIC CO.	5GA-D47
A4C3	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C4	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C5	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C6	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C7	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A4C8	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C9	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C10	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C11	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C12	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C13	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C14	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C15	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C16	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C17	11501-007	CAP CER .01UF 10% 50V	PHILLIPS/CENTRALAB	CW20C103K
A4C18	11501-007	CAP CER .01UF 10% 50V	PHILLIPS/CENTRALAB	CW20C103K
A4C19	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C20	11501-005	CAP CER 0.47UF 20% 50V	ERIE TECHNOLOGICAL	8131-050-Z5U-474M
A4C21	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C22	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C23	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C24	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C25	10001-004	CAP CER 22PF 5% 1000VDC	SPRAGUE ELECTRIC CO.	10TCC-Q22
A4C26	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C27	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C28	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C29	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C30	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C31	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C32	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C33	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C34	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C35	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C36	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C37	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C38	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C39	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C40	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C41	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C42	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C43	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C44	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C45	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C47	10581-003	CAP, VAR CERAMIC 9-35PF	ERIE TECHNOLOGICAL	538-006D-9-35
A4C52	10787-002	CAP TANTALUM 12MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D126X9020JA1
A4C53	10787-002	CAP TANTALUM 12MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D126X9020JA1
A4C54	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C55	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C56	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A4C57	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A4CR1	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A4CR2	11345	DIODE HPA 2900	HEWLETT PACKARD	5082-2900
A4Q1	10019	TRANSISTOR 2N3565	NATIONAL SEMICONDUCTOR	2N3565

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A4R1	10013-013	RES DEP CARB 100 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A4R2	10142-004	RES CARB COMP 22M OHM 5% 1/4W	ALLEN-BRADLEY CO.	RC07GF226J
A4R3	10013-055	RES DEP CARB 330K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A4R4	10013-029	RES DEP CARB 2.2K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A4R5	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A4R6	10013-061	RES DEP CARB 1M OHM 5% 1/4W	MEPCO/ELECTRA	B803 104NB 105
A4R7	10013-061	RES DEP CARB 1M OHM 5% 1/4W	MEPCO/ELECTRA	B803 104NB 105
A4R8	10013-061	RES DEP CARB 1M OHM 5% 1/4W	MEPCO/ELECTRA	B803 104NB 105
A4R9	10013-045	RES DEP CARB 47K OHM 5% 1/4W	MEPCO/ELECTRA	CR25 47K 5%
A4R10	10013-017	RES DEP CARB 220 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A4R11	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A4R12	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A4RP1	15098-003	RES NTWK SIP 4.7K OHM 2% 1/8W	ALLEN-BRADLEY CO.	108A472
A4RP2	15098-003	RES NTWK SIP 4.7K OHM 2% 1/8W	ALLEN-BRADLEY CO.	108A472
A4TP1	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A4TP2	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A4TP3	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A4TP4	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A4TP5	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A4TP6	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A4TP7	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A4TP8	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A4TP9	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A4TP10	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE

NOTE: ICs A4U2, U3, U4, U10, U27, U28, U29, and A4U35 are not supplied with A4. These are PROMs which contain the instrument software, and should be replaced only as a matched set. If replacement is required, order P/N 20803.

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A4U1	17023	INTEGRATED CKT MC146818P	MOTOROLA (SPD)	MC146818P
A4U5	17020	I.C. - MEMORY	HITACHI	HM6264LP-15
A4U6	17020	I.C. - MEMORY	HITACHI	HM6264LP-15
A4U7	13470-049	INTEGRATED CKT SN74LS244N	TEXAS INSTRUMENTS	SN74LS244N
A4U8	13470-049	INTEGRATED CKT SN74LS244N	TEXAS INSTRUMENTS	SN74LS244N
A4U9	13470-049	INTEGRATED CKT SN74LS244N	TEXAS INSTRUMENTS	SN74LS244N
A4U11	17020	I.C. - MEMORY	HITACHI	HM6264LP-15
A4U12	17044-001	I.C. - MICROPROCESSOR	HITACHI	HD68000-8
A4U13	13470-049	INTEGRATED CKT SN74LS244N	TEXAS INSTRUMENTS	SN74LS244N
A4U14	13470-047	INTEGRATED CKT SN74LS32N	TEXAS INSTRUMENTS	SN74LS32N
A4U15	13470-047	INTEGRATED CKT SN74LS32N	TEXAS INSTRUMENTS	SN74LS32N
A4U16	13470-060	INTEGRATED CKT SN74LS164N	TEXAS INSTRUMENTS	SN74LS164N
A4U17	13871	INTEGRATED CKT LM555CH	NATIONAL SEMICONDUCTOR	LM555CN
A4U18	13470-009	INTEGRATED CKT SN74LS27N	TEXAS INSTRUMENTS	SN74LS27N
A4U19	13470-004	INTEGRATED CKT SN74LS04N	TEXAS INSTRUMENTS	SN74LS04N
A4U20	13470-005	INTEGRATED CKT SN74LS08N	TEXAS INSTRUMENTS	SN74LS08N
A4U21	13470-006	INTEGRATED CKT SN74LS10N	TEXAS INSTRUMENTS	SN74LS10N
A4U22	13470-036	INTEGRATED CKT SN74LS05N	TEXAS INSTRUMENTS	SN74LS05N
A4U23	13470-005	INTEGRATED CKT SN74LS08N	TEXAS INSTRUMENTS	SN74LS08N
A4U24	13470-003	INTEGRATED CKT SN74LS02N	TEXAS INSTRUMENTS	SN74LS02N
A4U25	13470-047	INTEGRATED CKT SN74LS32N	TEXAS INSTRUMENTS	SN74LS32N

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A4U26	17048-001	INTEGRATED CIRCUIT	MOTOROLA (SPD)	MC74HCT00N
A4U30	17020	I.C. - MEMORY	HITACHI	HM6264LP-15
A4U31	17020	I.C. - MEMORY	HITACHI	HM6264LP-15
A4U32	13470-061	INTEGRATED CKT SN74LS245N	TEXAS INSTRUMENTS	SN74LS245N
A4U33	13470-061	INTEGRATED CKT SN74LS245N	TEXAS INSTRUMENTS	SN74LS245N
A4U34	13470-063	INTEGRATED CKT SN74LS154N	SIGNETICS	N74LS154N
A4U36	17020	I.C. - MEMORY	HITACHI	HM6264LP-15
A4U37	13470-059	INTEGRATED CKT SN74LS148N	TEXAS INSTRUMENTS	SN74LS148N
A4U38	13470-005	INTEGRATED CKT SN74LS08N	TEXAS INSTRUMENTS	SN74LS08N
A4U39	13470-013	INTEGRATED CKT SN74LS74N	TEXAS INSTRUMENTS	SN74LS74N
A4U40	13470-004	INTEGRATED CKT SN74LS04N	TEXAS INSTRUMENTS	SN74LS04N
A4U41	13470-004	INTEGRATED CKT SN74LS04N	TEXAS INSTRUMENTS	SN74LS04
A4Y1	17047-001	CRYSTAL, QUARTZ 32.768 KHZ	SARONIX	NTF3226E
A4Y2	17045-001	INTEGRATED CKT OSC 12.000MHZ	SARONIX	NCT-050C-12.000MHZ

DIGITAL DELAY PCB ASSY #16685

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A5C1	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C3	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A5C4	10787-002	CAP TANTALUM 12MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D126X9020JA1
A5C5	10787-002	CAP TANTALUM 12MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D126X9020JA1
A5C6	10001-004	CAP CER 22PF 5% 1000VDC	SPRAGUE ELECTRIC CO.	10TCC-Q22
A5C9	14119-001	POLYSTYRENE .01MF 2.5%	MALLORY	#SXMN110
A5C10	10787-002	CAP TANTALUM 12MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D126X9020JA1
A5C11	10787-002	CAP TANTALUM 12MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D126X9020JA1
A5C14	14119-004	CAP, PS, 220PF, 2.5%, 160V	MALLORY	SXM322
A5C15	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A5C16	10001-006	CAP CER 47PF 5% 1000VDC	SPRAGUE ELECTRIC CO.	10TCC-Q47
A5C18	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A5C21	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A5C22	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A5C23	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A5C24	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A5C25	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A5C26	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A5C27	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A5C28	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A5C29	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A5C30	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A5C31	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C32	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C33	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A5C34	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C35	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C36	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C37	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C38	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A5C39	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C40	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C41	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C42	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C43	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C44	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C48	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C49	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C50	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C51	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C52	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C53	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C54	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C55	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C56	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C57	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C58	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C59	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C60	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C61	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C62	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C63	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C64	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C66	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C67	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C68	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C69	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C70	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C71	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A5C72	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A5C76	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A5C77	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C78	11501-005	CAP CER 0.47UF 20% 50V	ERIE TECHNOLOGICAL	8131-050-Z5U-474M
A5C79	10581-003	CAP, VAR CERAMIC 9-35PF	ERIE TECHNOLOGICAL	538-006D-9-35
A5C80	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A5C81	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C82	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A5C83	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A5C84	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A5C85	10000-001	CAP CER 100PF 20% 1000VDC	PHILLIPS/CENTRALAB	DD101
A5C86	10000-001	CAP CER 100PF 20% 1000VDC	PHILLIPS/CENTRALAB	DD101
A5C87	10000-001	CAP CER 100PF 20% 1000VDC	PHILLIPS/CENTRALAB	DD101
A5C88	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A5C89	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C90	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A5C93	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C94	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C95	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C96	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C97	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A5C100	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C101	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A5C102	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A5C103	10787-012	CAP TANTALUM 2.2MF 35VDC	SPRAGUE ELECTRIC CO.	196D225X9035JA1
A5C104	10001-003	CAP CER 10pF 5% 1000VDC	SPRAGUE ELECTRIC CO.	10TCC-Q10
A5CR1	11345	DIODE HPA 2900	HEWLETT PACKARD	5082-2900
A5CR2	10045	DIODE 1N823 ZENER REF 6.2V 5%	SIEMENS	IN823
A5CR3	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A5L1	17175	INDUCTOR, 3.5 TURNS	WAVETEK MICROWAVE	17175
A5L3	17174	CHOKE, 1.5 TURN	WAVETEK MICROWAVE	17174
A5Q1	10018	TRANSISTOR 2N3646	FAIRCHILD	2N3646
A5Q5	10021-001	TRANSISTOR 2N3563	FAIRCHILD	PN3563
A5Q6	10021-001	TRANSISTOR 2N3563	FAIRCHILD	PN3563
A5Q7	10398	TRANSISTOR 2N4121 OR PN4917	NATIONAL SEMICONDUCTOR	2N4121
A5Q8	10398	TRANSISTOR 2N4121 OR PN4917	NATIONAL SEMICONDUCTOR	2N4121
A5Q9	10021-001	TRANSISTOR 2N3563	FAIRCHILD	PN3563
A5Q10	10021-001	TRANSISTOR 2N3563	FAIRCHILD	PN3563
A5Q13	10398	TRANSISTOR 2N4121 OR PN4917	NATIONAL SEMICONDUCTOR	2N4121
A5Q14	10398	TRANSISTOR 2N4121 OR PN4917	NATIONAL SEMICONDUCTOR	2N4121
A5R10	12449-033	RES MF 100K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A5R11	12449-033	RES MF 100K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A5R12	12449-033	RES MF 100K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A5R13	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A5R2	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R3	10013-033	RES DEP CARB 4.7K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R4	10013-033	RES DEP CARB 4.7K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R5	10015-019	RES MET FILM 1.0K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 1K OHM 1%
A5R6	10015-146	RES MET FILM 162 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 162 OHM 1%
A5R8	10015-019	RES MET FILM 1.0K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 1K OHM 1%
A5R9	10015-146	RES MET FILM 162 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 162 OHM 1%
A5R14	12449-033	RES MF 100K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A5R15	10013-017	RES DEP CARB 220 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R16	10015-140	RES MET FILM 499 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 499 OHM 1%
A5R17	10015-256	RES MET FILM 1.5K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 1.5K OHM 1%
A5R18	10013-029	RES DEP CARB 2.2K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R19	10013-013	RES DEP CARB 100 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R20	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A5R21	10015-146	RES MET FILM 162 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 162 OHM 1%
A5R22	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A5R23	10013-082	RES CARB FILM 5.1K OHM 5% 1/4W	MEPCO/ELECTRA	B803 104NB 512
A5R26	10013-013	RES DEP CARB 100 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R27	10013-013	RES DEP CARB 100 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R28	10015-164	RES MET FILM 475 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 475 OHM 1%
A5R29	10015-065	RES MET FILM 4.99K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 4.99K OHM 1%
A5R30	15142-004	RES VAR CERM 500 OHM 10% 1/2W	BECKMAN	66XR500
A5R31	10015-077	RES MET FILM 1.24K 1% 1/8W	CORNING GLASS WORKS	RN55D 1.24K OHM 1%
A5R32	12449-107	RES MF 100.0 OHM 0.1% 1/8W	DALE ELECTRONICS	MMF 1/8 T2
A5R33	12449-026	RES MF 5.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A5R34	10015-065	RES MET FILM 4.99K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 4.99K OHM 1%

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A5R35	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A5R36	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A5R37	12449-048	RES MF 15.00K OHM 0.1% 1/8W	DALE ELECTRONICS	MFF 1/8 T2
A5R38	12449-116	RES MF 750.0 OHM, 0.1%, 1/8W	DALE ELECTRONICS	MFF 1/8 T2
A5R39	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A5R40	10013-017	RES DEP CARB 220 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R41	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R42	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A5R43	10013-033	RES DEP CARB 4.7K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R44	10015-123	RES MET FILM 301 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 301 OHM 1%
A5R45	10015-171	RES MET FILM 698 OHM 1% 1/8W	MEPCO/ELECTRA	5053YD69820F
A5R46	10013-069	ES DEP CARB 4.7M OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R47	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R48	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A5R49	10013-049	RES DEP CARB 100K OHM 5% 1/4W	MEPCO/ELECTRA	CR25 100K 5%
A5R50	10013-049	RES DEP CARB 100K OHM 5% 1/4W	MEPCO/ELECTRA	CR25 100K 5%
A5R51	10015-207	RES MET FILM 20.0K OHM 1% 1/8W	CORNING GLASS WORKS	20K OHM 1%
A5R52	10015-207	RES MET FILM 20.0K OHM 1% 1/8W	CORNING GLASS WORKS	20K OHM 1%
A5R53	10013-086	RES CARB FILM 51 OHM 5% 1/4W	MEPCO/ELECTRA	B803 104NB 510
A5R54	10013-082	RES CARB FILM 5.1K OHM 5% 1/4W	MEPCO/ELECTRA	B803 104NB 512
A5R55	10013-076	RES DEP CARB 6.2K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R56	10013-086	RES CARB FILM 51 OHM 5% 1/4W	MEPCO/ELECTRA	B803 104NB 510
A5R57	10013-086	RES CARB FILM 51 OHM 5% 1/4W	MEPCO/ELECTRA	B803 104NB 510
A5R58	10013-086	RES CARB FILM 51 OHM 5% 1/4W	MEPCO/ELECTRA	B803 104NB 510
A5R59	10013-086	RES CARB FILM 51 OHM 5% 1/4W	MEPCO/ELECTRA	B803 104NB 510
A5R60	10013-035	RES DEP CARB 6.8K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R62	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A5R63	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A5R64	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A5R65	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R66	10013-018	RES DEP CARB 270 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R67	10013-041	RES DEP CARB 22K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R68	10013-041	RES DEP CARB 22K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A5R69	10015-003	RES MET FILM 49.9 OHM 1% 1/8W	LARTRONICS, INC.	RN55D 49.9 OHM 1% 1/8W
A5R70	10015-099	RES MET FILM 14.0K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 14K OHM 1%
A5R71	10015-359	RES MET FILM 52.3K 1% 1/8W	CORNING GLASS WORKS	RN55D 52.3K 1%
A5R72	10015-003	RES MET FILM 49.9 OHM 1% 1/8W	LARTRONICS, INC.	RN55D 49.9 OHM 1% 1/8W
A5R73	10015-099	RES MET FILM 14.0K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 14K OHM 1%
A5R74	10015-359	RES MET FILM 52.3K 1% 1/8W	CORNING GLASS WORKS	RN55D 52.3K 1%
A5R75	10015-256	RES MET FILM 1.5K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 1.5K OHM 1%
A5R76	10015-140	RES MET FILM 499 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 499 OHM 1%
A5R77	10015-180	RES MET FILM 280K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 280K OHM 1%
A5R78	10015-180	RES MET FILM 280K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 280K OHM 1%
A5RP1	14882-003	RES SIP NTWK 390 OHM 2% 125MW	ALLEN-BRADLEY CO.	110A-391
A5RP2	15098-005	RESISTOR, 390 OHM 2% 125MW	ALLEN-BRADLEY CO.	108A391
A5RP3	15098-005	RESISTOR, 390 OHM 2% 125MW	ALLEN-BRADLEY CO.	108A391
A5RP4	15098-005	RESISTOR, 390 OHM 2% 125MW	ALLEN-BRADLEY CO.	108A391
A5RP5	15098-005	RESISTOR, 390 OHM 2% 125MW	ALLEN-BRADLEY CO.	108A391
A5RP6	15098-005	RESISTOR, 390 OHM 2% 125MW	ALLEN-BRADLEY CO.	108A391
A5RP7	15098-005	RESISTOR, 390 OHM 2% 125MW	ALLEN-BRADLEY CO.	108A391

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A5RP8	14882-002	RESISTOR, 680 OHM 2% 125MW	CTS CORPORATION/ELKHART D	750-101-R680
A5RP9	15098-005	RESISTOR, 390 OHM 2% 125MW	ALLEN-BRADLEY CO.	108A391
A5RP10	14882-003	RES SIP NTWK 390 OHM 2% 125MW	ALLEN-BRADLEY CO.	110A-391
A5RP11	15098-005	RESISTOR, 390 OHM 2% 125MW	ALLEN-BRADLEY CO.	108A391
A5TP1	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5TP2	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5TP3	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5TP4	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5TP5	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5TP6	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5TP7	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5TP8	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5TP9	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5TP10	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5TP11	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5TP12	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5TP13	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5TP14	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5TP15	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5TP16	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5TP17	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5TP18	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A5U1	13470-018	INTEGRATED CKT SN74LS221N	TEXAS INSTRUMENTS	SN74LS221N
A5U2	13470-044	INTEGRATED CKT SN74LS138N	TEXAS INSTRUMENTS	SN74LS138N
A5U3	13470-013	INTEGRATED CKT SN74LS74N	TEXAS INSTRUMENTS	SN74LS74N
A5U4	13470-047	INTEGRATED CKT SN74LS32N	TEXAS INSTRUMENTS	SN74LS32N
A5U5	13470-032	INTEGRATED CKT SN74LS20N	TEXAS INSTRUMENTS	SN74LS20N
A5U6	14641	INTEGRATED CKT 8255	HARRIS CORP	CP82C55A
A5U7	14641	INTEGRATED CKT 8255	HARRIS CORP	CP82C55A
A5U8	13473-002	IC,SYNCHRONOUS 4-BIT COUNTER	TEXAS INSTRUMENTS	SN74S163N
A5U9	13470-041	INTEGRATED CKT SN74LS163N	TEXAS INSTRUMENTS	SN74LS163N
A5U10	13470-041	INTEGRATED CKT SN74LS163N	TEXAS INSTRUMENTS	SN74LS163N
A5U11	13470-041	INTEGRATED CKT SN74LS163N	TEXAS INSTRUMENTS	SN74LS163N
A5U12	13470-041	INTEGRATED CKT SN74LS163N	TEXAS INSTRUMENTS	SN74LS163N
A5U13	13620-006	INTEGRATED CKT MC10124P	MOTOROLA (SPD)	MC10124P
A5U14	13620-009	I.C. - DIGITAL TTL	FAIRCHILD	F10016DC
A5U15	17048-002	INTEGRATED CKT	MOTOROLA (SPD)	MC74HCT04N
A5U16	13470-025	INTEGRATED CKT SN74LS157N	TEXAS INSTRUMENTS	SN74LS157N
A5U17	13470-013	INTEGRATED CKT SN74LS74N	TEXAS INSTRUMENTS	SN74LS74N
A5U19	13620-006	INTEGRATED CKT MC10124P	MOTOROLA (SPD)	MC10124P
A5U20	13470-001	INTEGRATED CKT SN74LS00N	TEXAS INSTRUMENTS	SN74LS00N
A5U21	13620-007	INTEGRATED CKT MC10125P	MOTOROLA (SPD)	MC10125P
A5U22	13470-018	INTEGRATED CKT SN74LS221N	TEXAS INSTRUMENTS	SN74LS221N
A5U23	13620-001	INTEGRATED CKT MC10105P	MOTOROLA (SPD)	MC10105P
A5U24	17239-002	IC,TRI 2-3-2-INPUT OR/NOR GATE	MOTOROLA (SPD)	MC10H105P
A5U25	13620-002	INTEGRATED CKT MC10131P	MOTOROLA (SPD)	MC10131P
A5U26	13620-008	INTEGRATED CKT MC10198P	MOTOROLA (SPD)	MC10198P
A5U27	17239-002	IC,TRI 2-3-2-INPUT OR/NOR GATE	MOTOROLA (SPD)	MC10H105P
A5U28	17239-001	IC, QUAD 2 - INPUT & GATE	MOTOROLA (SPD)	MC10H104P
A5U29	17239-005	IC, DL TYPE D MASTER-SLAVE F/F	MOTOROLA (SPD)	MC10H131P

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A5U30	17239-004	IC 4X OR-AND/OR-AND-INVT GATE	MOTOROLA (SPD)	MC10H121P
A5U31	13620-006	INTEGRATED CKT MC10124P	MOTOROLA (SPD)	MC10124P
A5U32	14621	INTEGRATED CKT LM358N	NATIONAL SEMICONDUCTOR	LM358N
A5U33	15119	INTEGRATED CKT DG201CJ	SILICONIX	DG201ACJ
A5U34	17061	INTEGRATED CKT SP9685CM	PLESSEY SEMICONDUCTOR	SP9685CM
A5U35	13620-003	INTEGRATED CKT MC10101P	MOTOROLA (SPD)	MC10101P
A5U36	14644	INTEGRATED CKT DAC08EQ	PRECISION MONOLITHICS	DAC08EQ
A5U37	14624	INTEGRATED CKT TL072CP	TEXAS INSTRUMENTS	TL072CP
A5U38	13620-008	INTEGRATED CKT MC10198P	MOTOROLA (SPD)	MC10198P
A5U39	20771	ULTRAFAST DUAL COMPARATOR	ANALOG DEVICES	AD96687BQ
A5U40	14645	INTEGRATED CKT AD561JD	ANALOG DEVICES	AD561AJD
A5U41	14621	INTEGRATED CKT LM358N	NATIONAL SEMICONDUCTOR	LM358N
A5U42	13470-018	INTEGRATED CKT SN74LS221N	TEXAS INSTRUMENTS	SN74LS221N
A5Y1	17046-001	CRYSTAL, QUARTZ 39.0625 MHZ	UNITED STATES CRYSTAL COR	CR-117/U 39.062500MHZ

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NOTE: PC boards A6 and A7 are identical. Both boards are used in the Model 8502A, whereas the Model 8501A uses only A6.

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A6C1	10787-002	CAP TANTALUM 12MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D126X9020JA1
A6C2	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C3	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C4	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C5	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C6	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C7	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C8	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C9	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C10	10787-002	CAP TANTALUM 12MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D126X9020JA1
A6C11	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C12	10787-002	CAP TANTALUM 12MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D126X9020JA1
A6C13	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C14	10787-002	CAP TANTALUM 12MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D126X9020JA1
A6C15	15776-006	CAP, CERAM. .47UF +- 10% 50V	PHILLIPS/CENTRALAB	CW40C4T4K
A6C16	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C17	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C18	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C19	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A6C20	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C21	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C22	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C23	14119-001	POLYSTYRENE .01MF 2.5%	MALLORY	SXM\110
A6C24	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C25	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A6C26	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A6C27	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A6C29	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C30	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A6C31	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C32	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C33	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A6C34	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A6C36	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C37	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C38	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C39	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C40	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A6C41	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C42	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C44	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C45	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C46	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C47	10909-002	CAP MICA 470PF 1% 500V	ARCO	CM06FD471FO3
A6C48	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C49	15776-002	CAP, CER .001 MF 10% 50V	PHILLIPS/CENTRALAB	CW15C102K
A6C51	10787-002	CAP TANTALUM 12MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D126X9020JA1
A6C52	10787-002	CAP TANTALUM 12MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D126X9020JA1
A6C53	10787-002	CAP TANTALUM 12MF 20% 20VDC	SPRAGUE ELECTRIC CO.	196D126X9020JA1
A6C54	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C56	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C57	10909-002	CAP MICA 470PF 1% 500V	ARCO	CM06FD471FO3
A6C60	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C62	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C63	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C64	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C65	15776-004	CAP,CER .0022 MFD 10% 50V	PHILLIPS/CENTRALAB	CW15C222K
A6C66	15776-013	CAP CER 220PF 10% 50V	PHILLIPS/CENTRALAB	CW15C221K
A6C67	15776-011	CAP,CER 2700PF 10% 50V	PHILLIPS/CENTRALAB	CW15C272K
A6C68	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A6C69	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C70	14119-005	CAP POLYSTYR 2400PF 2.5% 160V	MALLORY	SXM224
A6C71	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C72	10001-014	CAP CER TC 68PF 5% 1000VDC	MALLORY	CPC680J
A6C78	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C79	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C80	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C81	11501-003	CAP.,CER.,100PF,+-10%,100V	MURATA/ERIE CORP	RPE110C0G101J100V
A6C93	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C94	15776-004	CAP,CER .0022 MFD 10% 50V	PHILLIPS/CENTRALAB	CW15C222K
A6C97	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C99	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C100	15776-013	CAP CER 220PF 10% 50V	PHILLIPS/CENTRALAB	CW15C221K
A6C101	16258-003	CAP METAL POLY 0.47UF 10% 63V	WIMA	MKS2-0.47-63-10
A6C102	15776-007	CAP,CER. 470PF 10% 50V	PHILLIPS/CENTRALAB	CW15C471K
A6C106	15776-018	CAP, Ceramic,4700pF X7R, 50V	PHILLIPS/CENTRALAB	CW15C472K
A6C107	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C108	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C109	19599-005	CAP ELCTLT RDL 3.3uF 20% 50V	NICHICON (AMERICA) CORP.	UVX1H3R3MAA

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A6C110	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C111	19599-005	CAP ELCTLT RDL 3.3uF 20% 50V	NICHICON (AMERICA) CORP.	UVX1H3R3MAA
A6C112	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C113	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C114	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C115	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A6C116	15776-028	CAP CER 100PF 10% 50V	PHILLIPS/CENTRALAB	CW20C101K
A6CR1	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A6CR2	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A6CR3	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A6CR4	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A6CR5	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A6CR6	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A6CR7	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A6CR8	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A6CR10	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A6CR11	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A6CR12	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A6CR13	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A6CR14	13625	DIODE, 5082-2826	HEWLETT PACKARD	5082-2826
A6CR16	13625	DIODE, 5082-2826	HEWLETT PACKARD	5082-2826
A6CR17	13625	DIODE, 5082-2826	HEWLETT PACKARD	5082-2826
A6CR18	13625	DIODE, 5082-2826	HEWLETT PACKARD	5082-2826
A6CR19	3625	DIODE, 5082-2826	HEWLETT PACKARD	5082-2826
A6CR20	0043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A6CR21	0043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A6CR22	3625	DIODE, 5082-2826	HEWLETT PACKARD	5082-2826
A6Q1	10017	TRANSISTOR 2N3569	NATIONAL SEMICONDUCTOR	2N3569
A6Q2	10018	TRANSISTOR 2N3646	FAIRCHILD	2N3646
A6Q3	10398	TRANSISTOR 2N4121 OR PN4917	NATIONAL SEMICONDUCTOR	2N4121
A6Q4	10018	TRANSISTOR 2N3646	FAIRCHILD	2N3646
A6R1	10013-031	RES DEP CARB 3.3K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R2	10013-031	RES DEP CARB 3.3K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R3	10013-031	RES DEP CARB 3.3K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R4	10013-031	RES DEP CARB 3.3K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R5	10015-003	RES MET FILM 49.9 OHM 1% 1/8W	LARTRONICS, INC.	RN55D 49.9 OHM 1% 1/8W
A6R6	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R7	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R8	10013-017	RES DEP CARB 220 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R9	10015-007	RES MET FILM 10.0K OHM 1% 1/8W	LARTRONICS, INC.	10.0K OHM 1% 1/8W
A6R10	10013-019	RES DEP CARB 330 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R11	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R12	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R13	15142-004	RES VAR CERM 500 OHM 10% 1/2W	BECKMAN	66XR500
A6R14	12449-004	RES MF 2.681K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R15	12449-013	RES MF 18.75K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R16	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R17	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R18	10013-017	RES DEP CARB 220 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R19	10013-045	RES DEP CARB 47K OHM 5% 1/4W	MEPCO/ELECTRA	CR25 47K 5%

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A6R20	10015-065	RES MET FILM 4.99K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 4.99K OHM 1%
A6R21	10015-007	RES MET FILM 10.0K OHM 1% 1/8W	LARTRONICS, INC.	10.0K OHM 1% 1/8W
A6R22	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R23	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R24	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R25	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R26	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R27	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R28	12449-013	RES MF 18.75K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R29	12449-004	RES MF 2.681K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R30	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R31	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R32	10013-033	RES DEP CARB 4.7K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R33	10015-065	RES MET FILM 4.99K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 4.99K OHM 1%
A6R34	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R35	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R36	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R37	10015-065	RES MET FILM 4.99K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 4.99K OHM 1%
A6R38	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R39	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R40	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R41	10015-065	RES MET FILM 4.99K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 4.99K OHM 1%
A6R42	10015-114	RES MET FILM 75K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 75K OHM 1%
A6R43	10015-007	RES MET FILM 10.0K OHM 1% 1/8W	LARTRONICS, INC.	10.0K OHM 1% 1/8W
A6R44	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R45	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R46	10015-087	RES MET FILM 15.0K OHM 1% 1/8W	CORNING GLASS WORKS	RNM55D 15K OHM 1%
A6R47	15142-003	RES VAR CERM 1K OHM 10% 1/2W	BECKMAN	67XR1K
A6R48	10015-206	RES MET FILM 7.50K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 7.50K OHM 1%
A6R49	10015-057	RES MET FILM 8.66K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 8.66K OHM 1%
A6R50	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R51	10015-230	RES MET FILM 11.0K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 11K OHM 1%
A6R52	10015-098	RES MET FILM 13.3K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 13.3K OHM 1%
A6R53	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R54	10015-028	RES MET FILM 23.7K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 23.7K 1%
A6R55	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R56	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R57	12449-008	RES MF 30.58K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R58	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R59	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R60	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R61	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R62	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R63	12449-013	RES MF 18.75K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R64	12449-004	RES MF 2.681K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R65	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R66	10013-053	RES DEP CARB 220K OHM 5% 1/4W	EPCO/ELECTRA	RCO72FxxxJ
A6R67	10013-053	RES DEP CARB 220K OHM 5% 1/4W	EPCO/ELECTRA	RCO72FxxxJ
A6R68	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R69	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A6R70	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R71	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R72	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R73	10015-207	RES MET FILM 20.0K OHM 1% 1/8W	CORNING GLASS WORKS	20K OHM 1%
A6R74	12449-037	RES MF 20.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R75	10015-019	RES MET FILM 1.0K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 1K OHM 1%
A6R76	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R77	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R78	10013-006	RES DEP CARB 27 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R79	10013-006	RES DEP CARB 27 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R80	10013-039	RES DEP CARB 15K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R81	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R82	12449-119	RES MF 16.00K OHM 0.1% 1/8W	MEPCO/ELECTRA	RCO72FxxxJ
A6R83	12449-052	RES MF 39.96K OHM 0.1% 1/8W	DALE ELECTRONICS	MFF 1/8 T2
A6R84	12449-090	RES MF 8.000K OHM 0.1% 1/8W	PRECISION RESISTIVE PRODU	GP 1/4 TC50
A6R85	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R86	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R87	10013-053	RES DEP CARB 220K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R88	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R89	10013-053	RES DEP CARB 220K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R90	12449-013	RES MF 18.75K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R91	12449-004	RES MF 2.681K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R93	10013-039	RES DEP CARB 15K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R94	10013-039	RES DEP CARB 15K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R95	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R97	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R98	12449-051	RES MF 2.000K OHM 0.1% 1/8W	DALE ELECTRONICS	MFF 1/8 T2
A6R99	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R100	12449-051	RES MF 2.000K OHM 0.1% 1/8W	DALE ELECTRONICS	MFF 1/8 T2
A6R101	12449-118	RES MF 953.3 OHM 0.1% 1/8W	DALE ELECTRONICS	MFF 1/8 T2
A6R102	10015-019	RES MET FILM 1.0K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 1K OHM 1%
A6R103	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R104	10015-130	RES MET FILM 78.7 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 78.7 OHM 1% 1/8W
A6R109	10015-003	RES MET FILM 49.9 OHM 1% 1/8W	LARTRONICS, INC.	RN55D 49.9 OHM 1% 1/8W
A6R110	10015-323	RES MET FILM 22.1 OHM 1% 1/8W	CORNING GLASS WORKS	
A6R111	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R112	15142-002	RES VAR CERM 100K OHM 10% 1/2W	BECKMAN	67XR100K
A6R113	15142-007	RES VAR CERM 10KOHM 10% 1/2W	BECKMAN	67XR10K
A6R114	10015-013	RES MET FILM 100K OHM 1 % 1/8W	CORNING GLASS WORKS	RN55D 100K OHM 1%
A6R115	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R116	12449-019	RES MF 1.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R117	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R119	10013-029	RES DEP CARB 2.2K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R120	10013-065	RES DEP CARB 2.2M OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R122	10015-054	RES MET FILM 110K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 110K OHM 1%
A6R123	10015-068	RES MET FILM 100 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 100 OHM 1%
A6R125	10013-043	RES DEP CARB 33K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R131	10015-003	RES MET FILM 49.9 OHM 1% 1/8W	LARTRONICS, INC.	RN55D 49.9 OHM 1% 1/8W
A6R132	10015-111	RES MET FILM 24.9 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 24.9 OHM 1% 1/8W
A6R135	10015-150	RES MET FILM 46.4 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 46.4 OHM 1%

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A6R136	10142-004	RES CARB COMP 22M OHM 5% 1/4W	ALLEN-BRADLEY CO.	RC07GF226J
A6R138	12449-117	RES MF 29.28K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R139	10013-029	RES DEP CARB 2.2K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R140	12449-021	RES MF 10.00K OHM 0.1% 1/8W	ACI	EE 1/8 C2
A6R141	10015-068	RES MET FILM 100 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 100 OHM 1%
A6R142	10013-029	RES DEP CARB 2.2K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R143	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R144	10013-055	RES DEP CARB 33OK OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R145	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R146	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R147	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R148	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R149	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A6R152	10015-186	RES MET FILM 10.0 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 10 OHM 1%
A6R153	10015-186	RES MET FILM 10.0 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 10 OHM 1%
A6R154	10015-186	RES MET FILM 10.0 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 10 OHM 1%
A6R155	10015-186	RES MET FILM 10.0 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 10 OHM 1%
A6R156	10015-225	RES MET FILM 3.32K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 3.32K OHM 1%
A6R158	10015-112	RES MET FILM 374 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 374K OHM 1%
A6R160	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R161	10142-008	RES CARB COMP 47 OHM 5% 1/4W	LARTRONICS, INC.	RC07GF470J
A6R163	10015-140	RES MET FILM 499 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 499 OHM 1%
A6R164	10015-112	RES MET FILM 374 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 374K OHM 1%
A6R165	10015-111	RES MET FILM 24.9 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 24.9 OHM 1% 1/8W
A6R166	10015-068	RES MET FILM 100 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 100 OHM 1%
A6R167	10015-065	RES MET FILM 4.99K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 4.99K OHM 1%
A6T1	20131	TRANSFORMER,SAMPLER	ZAMBRE CO	PER WMI PRINT
A6TP1	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A6TP2	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A6TP3	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A6TP4	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A6TP5	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A6TP6	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A6TP7	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A6TP8	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A6TP9	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A6TP10	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A6TP11	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A6TP12	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A6TP13	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A6U1	14641	INTEGRATED CKT 8255	HARRIS CORP	CP82C55A
A6U3	13470-009	INTEGRATED CKT SN74LS27N	TEXAS INSTRUMENTS	SN74LS27N
A6U5	13470-047	INTEGRATED CKT SN74LS32N	TEXAS INSTRUMENTS	SN74LS32N
A6U6	17158-001	IC DIGITAL	NATIONAL SEMICONDUCTOR	DM74ALS873N
A6U7	17021	I.C. - DIGITAL TTL	ANALOG DEVICES	AD574AJN
A6U8	15214	IC AD7542AD 12 BIT CMDS DAC	ANALOG DEVICES	AD7542AD
A6U9	14632	INTEGRATED CKT MM74CO4N	NATIONAL SEMICONDUCTOR	MM74C04N
A6U10	14632	INTEGRATED CKT MM74CO4N	NATIONAL SEMICONDUCTOR	MM74C04N
A6U11	15135	INTEGRATED CKT HA7-5135-5	PRECISION MONOLITHICS	OP-07/CP

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A6U12	15135	INTEGRATED CKT HA7-5135-5	PRECISION MONOLITHICS	OP-07/CP
A6U13	15119	INTEGRATED CKT DG201CJ	SILICONIX	DG201ACJ
A6U14	13471	INTEGRATED CKT LM324N	SGS	LM324AN
A6U15	15119	INTEGRATED CKT DG201CJ	SILICONIX	DG201ACJ
A6U16	16325	INTEGRATED CKT LF398AN	SIGNETICS	LF398N
A6U17	19490	INTEGRATED CKT MC34074	MOTOROLA (SPD)	MC34074P
A6U18	15135	INTEGRATED CKT HA7-5135-5	PRECISION MONOLITHICS	OP-07/CP
A6U19	15135	INTEGRATED CKT HA7-5135-5	PRECISION MONOLITHICS	OP-07/CP
A6U20	15119	INTEGRATED CKT DG201CJ	SILICONIX	DG201ACJ
A6U21	13471	INTEGRATED CKT LM324N	SGS	LM324AN
A6U22	15119	INTEGRATED CKT DG201CJ	SILICONIX	DG201ACJ
A6U23	15141	IC, VOLT QUAD COMP LM339N	NATIONAL SEMICONDUCTOR	LM339N
A6U25	20899	I.C. CMOS ANAL SW, QUAD SPST	SILICONIX	DG444DJ
A6U26	15135	INTEGRATED CKT HA7-5135-5	PRECISION MONOLITHICS	OP-07/CP
A6U27	15135	INTEGRATED CKT HA7-5135-5	PRECISION MONOLITHICS	OP-07/CP
A6U28	14669	I C INPUT OP AMP J FET LF356N	NATIONAL SEMICONDUCTOR	LF356N
A6U29	14669	I C INPUT OP AMP J FET LF356N	NATIONAL SEMICONDUCTOR	LF356N
A6U30	20766	IC HI-SPEED LOW-PWR ML OP AMP	ANALOG DEVICES	AD847JN
A6U31	21264	IC, VIDEO BUFFER HA3-5002-5	HARRIS CORP	HA3-5002-5
A6U32	15119	INTEGRATED CKT DG201CJ	SILICONIX	DG201ACJ
A6U33	21264	IC, VIDEO BUFFER HA3-5002-5	HARRIS CORP	HA3-5002-5
A6XR141	0182	SHIELDING BEAD FERROXCUBE	PHILIPS COMPONENTS	56-59065/3B
A6XR166	0182	SHIELDING BEAD FERROXCUBE	PHILIPS COMPONENTS	56-59065/3B

FRONT PANEL INTERFACE PCB ASSY #20195

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A8C2	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C3	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C4	19599-007	CAP ELCTLT RDL 22uF 20% 50V	NICHICON (AMERICA) CORP.	ULB1H220MAA
A8C6	15776-006	CAP, CERAM. .47UF +- 10% 50V	PHILLIPS/CENTRALAB	CW40C4T4K
A8C11	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C12	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C19	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C20	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C21	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C25	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C26	15776-006	CAP, CERAM. .47UF +- 10% 50V	PHILLIPS/CENTRALAB	CW40C4T4K
A8C27	15776-006	CAP, CERAM. .47UF +- 10% 50V	PHILLIPS/CENTRALAB	CW40C4T4K
A8C28	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A8C30	19599-003	CAP ELCTLT RDL 1.0uF 20% 50V	NICHICON (AMERICA) CORP.	ULB1H010MAA
A8C31	15776-007	CAP,CER. 470PF 10% 50V	PHILLIPS/CENTRALAB	CW15C471K
A8C32	15776-007	CAP,CER. 470PF 10% 50V	PHILLIPS/CENTRALAB	CW15C471K
A8C33	15776-007	CAP,CER. 470PF 10% 50V	PHILLIPS/CENTRALAB	CW15C471K
A8C34	15776-007	CAP,CER. 470PF 10% 50V	PHILLIPS/CENTRALAB	CW15C471K
A8C35	15776-006	CAP, CERAM. .47UF +- 10% 50V	PHILLIPS/CENTRALAB	CW40C4T4K
A8C36	15776-006	CAP, CERAM. .47UF +- 10% 50V	PHILLIPS/CENTRALAB	CW40C4T4K
A8C37	15776-007	CAP,CER. 470PF 10% 50V	PHILLIPS/CENTRALAB	CW15C471K

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A8C38	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C40	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C41	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C42	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C43	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C44	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C45	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C46	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C47	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C50	16258-001	CAP MET MYLAR 1.0MFD 50V 10%	WIMA	MKS\1.0UF\10%
A8C51	16258-006	CAP METAL POLY 0.1uF 10% 63V	WIMA	MKS2/0.1uF/10%/63
A8C52	15776-003	CAP,CER .022 MFD 10% 50V	PHILLIPS/CENTRALAB	W15C223K
A8C53	15776-011	CAP,CER 2700PF 10% 50V	PHILLIPS/CENTRALAB	CW15C272K
A8C55	16258-006	CAP METAL POLY 0.1uF 10% 63V	WIMA	MKS2/0.1uF/10%/63
A8C56	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A8C57	20725-001	CAP ELCTLT RDL 470UF 20% 25V	NICHICON (AMERICA) CORP.	UVXIE471MPA
A8C58	15776-004	CAP,CER .0022 MFD 10% 50V	PHILLIPS/CENTRALAB	CW15C222K
A8C59	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A8C60	15776-018	CAP, Ceramic,4700pF X7R, 50V	PHILLIPS/CENTRALAB	CW15C472K
A8C61	19598-006	CAP ELCTLT 100UF 20% 25V RDL	NICHICON (AMERICA) CORP.	ULB1E101MAA
A8C62	16258-001	CAP MET MYLAR 1.0MFD 50V 10%	WIMA	MKS\1.0UF\10%
A8C63	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A8C65	20726-001	CAP ELCTLT RDL 47UF 20% 100V	NICHICON (AMERICA) CORP.	UVX2A470MPA
A8C66	20726-001	CAP ELCTLT RDL 47UF 20% 100V	NICHICON (AMERICA) CORP.	UVX2A470MPA
A8C67	20085-002	CAP ELCTLT 4.7uF -10/+50% 250V	RUBYCON AMERICA INC	250TWSH4.7
A8C68	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A8C70	20085-002	CAP ELCTLT 4.7uF -10/+50% 250V	RUBYCON AMERICA INC	250TWSH4.7
A8C71	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A8C72	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A8C73	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A8C74	15776-001	CAP, CER .01MF 10% 50V	PHILLIPS/CENTRALAB	CW15C103K
A8C75	15776-005	CAP,CER 0.1 MF 10% 50V	PHILLIPS/CENTRALAB	CW20C104K
A8CR1	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A8CR2	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A8CR5	20009	DIODE FAST RECOVERY 1N4937	MOTOROLA (SPD)	1N4937
A8CR8	10043	DIODE 1N4148/1N914	NATIONAL SEMICONDUCTOR	1N4148
A8CR9	20628	DIODE, FAST RECOVERY, MUR140	MOTOROLA (SPD)	MUR140
A8CR11	20628	DIODE, FAST RECOVERY, MUR140	MOTOROLA (SPD)	MUR140
A8CR14	20009	DIODE FAST RECOVERY 1N4937	MOTOROLA (SPD)	1N4937
A8J1	20553-001	CONN HEADER STR 2 ROW 26 POS	AMP, INC.	1-87227-3
A8L1	20566	INDUCTOR, 30uH 1.2A	TOKIN MAGNETICS, INC.	PER WMI PRINT
A8Q1	20558	TRANSISTOR, PWR FET IRF540	INTERNATIONAL RECTIFIER	IRF540
A8Q2	20554	TRANSISTOR, FET 2N7000	MOTOROLA (SPD)	2N7000
A8R2	10013-001	RES DEP CARB 10 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R4	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R5	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R6	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R7	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R17	10015-065	RES MET FILM 4.99K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 4.99K OHM 1%

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A8R18	10013-061	RES DEP CARB 1M OHM 5% 1/4W	MEPCO/ELECTRA	B803 104NB 105
A8R23	10015-065	RES MET FILM 4.99K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 4.99K OHM 1%
A8R24	10013-061	RES DEP CARB 1M OHM 5% 1/4W	MEPCO/ELECTRA	B803 104NB 105
A8R27	10013-053	RES DEP CARB 220K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R28	10013-019	RES DEP CARB 330 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R29	10013-019	RES DEP CARB 330 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R30	10013-053	RES DEP CARB 220K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R31	10013-047	RES DEP CARB 68K OHM 5% 1/4W	MEPCO/ELECTRA	CR25 68K 5%
A8R32	10013-017	RES DEP CARB 220 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R33	15142-011	RES VAR CERM, 2K 10% 1/2W	BECKMAN	67XR2K
A8R34	10015-021	RES MET FILM 4.64K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 4.64K OHM 1%
A8R35	10013-005	RES DEP CARB 22 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R36	10015-063	RES MET FILM 402K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 402K OHM 1%
A8R37	10013-075	RES DEP CARB 3.0K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R38	10013-005	RES DEP CARB 22 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R39	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R40	10013-001	RES DEP CARB 10 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R41	10013-017	RES DEP CARB 220 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R42	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R43	10013-020	RES DEP CARB 390 OHM 5% 1/4W	MEPCO/ELECTRA	CR25-390 OHM 5%
A8R44	20565-001	RES W.W. 0.25 OHM 1% 1/4W	DALE ELECTRONICS	NS-1/4-0.25 OHM 1%
A8R49	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R50	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R52	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R55	10013-001	RES DEP CARB 10 OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R57	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R58	10015-006	RES MET FILM 464K OHM 1% 1/8W	LARTRONICS, INC.	RN55D 464K OHM 1% 1/8W
A8R59	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R60	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R61	10013-025	RES DEP CARB 1K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8R62	10013-049	RES DEP CARB 100K OHM 5% 1/4W	MEPCO/ELECTRA	CR25 100K 5%
A8R63	10013-049	RES DEP CARB 100K OHM 5% 1/4W	MEPCO/ELECTRA	CR25 100K 5%
A8R64	10013-037	RES DEP CARB 10K OHM 5% 1/4W	MEPCO/ELECTRA	RCO72FxxxJ
A8RP1	14881-005	RES SIP(8x4R) 22 OHM 2% 1/8W	ALLEN-BRADLEY CO.	108B220
A8RP2	14881-005	RES SIP(8x4R) 22 OHM 2% 1/8W	ALLEN-BRADLEY CO.	108B220
A8RP3	15098-001	RES, SIP NETWK 1K OHM 2% 1/8W	ALLEN-BRADLEY CO.	106A102
A8RP4	15098-001	RES, SIP NETWK 1K OHM 2% 1/8W	ALLEN-BRADLEY CO.	106A102
A8RP5	15098-006	RES SIP 470 OHM 2% 1/8W	ALLEN-BRADLEY CO.	108A471
A8T1	20634	TRANSFORMER, FLYBACK	TOKIN MAGNETICS, INC.	WMI 20634
A8TP1	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A8TP2	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A8TP3	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A8TP4	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A8TP5	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A8TP6	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A8TP7	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A8TP8	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A8TP9	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A8TP10	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A8TP11	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A8TP12	14320-002	TEST JACK PIN	OVERLAND PRODUCTS	330.100 W/TIN PLATE
A8U1	17020	I.C. - MEMORY	HITACHI	HM6264LP-15
A8U2	17024	INTEGRATED CKT D8279	INTEL	D8279
A8U3	13470-034	INTEGRATED CKT SN74LS175N	TEXAS INSTRUMENTS	SN74LS175N
A8U4	15101	INTEGRATED CIRCUIT DS3611	NATIONAL SEMICONDUCTOR	DS3611N
A8U5	13470-064	INTEGRATED CKT SN74LS156N	MOTOROLA (SPD)	SN74LS156N
A8U6	13470-018	INTEGRATED CKT SN74LS221N	TEXAS INSTRUMENTS	SN74LS221N
A8U7	15100	INTEGRATED CKT CA3082	RCA	CA3082E
A8U8	17212	IC, DUAL TIMER	NATIONAL SEMICONDUCTOR	LM556N
A8U9	13470-004	INTEGRATED CKT SN74LS04N	TEXAS INSTRUMENTS	SN74LS04N
A8U10	20761	PAL, FRONT PANEL KNOB LOGIC	WAVETEK MICROWAVE	20761
A8U11	20564	IC DOT-MAT GRPH DSPL CONT	HITACHI	HD61830B00H
A8U12	13470-047	INTEGRATED CKT SN74LS32N	TEXAS INSTRUMENTS	SN74LS32N
A8U13	17048-002	INTEGRATED CKT	MOTOROLA (SPD)	MC74HCT04N
A8U14	13470-003	INTEGRATED CKT SN74LS02N	TEXAS INSTRUMENTS	SN74LS02N
A8U15	17714	INTEGRATED CKT LM358AN	TEXAS INSTRUMENTS	LM358AP
A8U16	13470-046	INTEGRATED CIRCUIT SN74LS161AN	TEXAS INSTRUMENTS	SN74LS161AN
A8U17	13470-018	INTEGRATED CKT SN74LS221N	TEXAS INSTRUMENTS	SN74LS221N
A8U18	13470-013	INTEGRATED CKT SN74LS74N	TEXAS INSTRUMENTS	SN74LS74N
A8U19	20556	IC SWITCHING REG PWM	UNITRODE	UC3845
A8U21	14621	INTEGRATED CKT LM358N	NATIONAL SEMICONDUCTOR	LM358N
A8U22	20723	I/C LINEAR 12V REG	MOTOROLA (SPD)	MC78T12CT
A8U20	20555	IC +12V OUTPUT VOLT REG	MOTOROLA (SPD)	MC78L12ACP
A8Y1	20629	IC CLK OSC 4.0 MHz @100 ppm	COMCLOK	CCO 100A 4.0000 MHz

FRONT PANEL PCB ASSY (MODEL 8501A) #20526-001

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A9CR1	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR2	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR3	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR4	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR5	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR6	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR7	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR8	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR9	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR10	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9S1	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S2	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S3	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S4	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S5	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S6	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S7	17032-001	SWITCH PB LIGHTED MOM PCB MTG	LICON (DIV. OF ITW INC.)	39-22100
A9S7	17032-002	LIGHTPIPE PB SWITCH 17032-001	LICON (DIV. OF ITW INC.)	80-390100

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A9S8	17032-001	SWITCH PB LIGHTED MOM PCB MTG	LICON (DIV. OF ITW INC.)	39-22100
A9S8	17032-002	LIGHTPIPE PB SWITCH 17032-001	LICON (DIV. OF ITW INC.)	80-390100
A9S9	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S10	17032-001	SWITCH PB LIGHTED MOM PCB MTG	LICON (DIV. OF ITW INC.)	39-22100
A9S10	17032-002	LIGHTPIPE PB SWITCH 17032-001	LICON (DIV. OF ITW INC.)	80-390100
A9S11	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S13	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S14	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S15	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S16	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S17	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S18	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S19	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S20	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S21	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S22	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S23	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S24	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S25	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S26	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S27	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500

FRONT PANEL PCB ASSY (MODEL 8502A) #20526-002

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A9CR1	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR2	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR3	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR4	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR5	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR6	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR7	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR8	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR9	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR10	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR11	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9CR12	17206-001	LED, ULTRA-BRIGHT YELLOW	HEWLETT PACKARD	HLMP-1440SO2
A9S1	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S2	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S3	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S4	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S5	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S6	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S7	17032-001	SWITCH PB LIGHTED MOM PCB MTG	LICON (DIV. OF ITW INC.)	39-22100
A9S7	17032-002	LIGHTPIPE PB SWITCH 17032-001	LICON (DIV. OF ITW INC.)	80-390100
A9S8	17032-001	SWITCH PB LIGHTED MOM PCB MTG	LICON (DIV. OF ITW INC.)	39-22100
A9S8	17032-002	LIGHTPIPE PB SWITCH 17032-001	LICON (DIV. OF ITW INC.)	80-390100
A9S9	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S10	17032-001	SWITCH PB LIGHTED MOM PCB MTG	LICON (DIV. OF ITW INC.)	39-22100

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A9S10	17032-002	LIGHTPIPE PB SWITCH 17032-001	LICON (DIV. OF ITW INC.)	80-390100
A9S11	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S12	17032-001	SWITCH PB LIGHTED MOM PCB MTG	LICON (DIV. OF ITW INC.)	39-22100
A9S12	17032-002	LIGHTPIPE PB SWITCH 17032-001	LICON (DIV. OF ITW INC.)	80-390100
A9S13	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S14	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S15	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S16	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S17	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S18	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S19	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S20	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S21	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S22	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S23	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S24	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S25	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S26	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S27	17031-001	SWITCH PB MOMENTARY PCB MTG	LICON (DIV. OF ITW INC.)	39-22500
A9S28	17032-001	SWITCH PB LIGHTED MOM PCB MTG	LICON (DIV. OF ITW INC.)	39-22100
A9S28	17032-002	LIGHTPIPE PB SWITCH 17032-001	LICON (DIV. OF ITW INC.)	80-390100

1GHz CALIBRATOR ASSY (TYPE N CONNECTOR) #20055-001

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A12AT1	19192-001	ATTEN CHIP LOW PWR 4GHZ 9dB	KDI PYROFILM CORP	TCAW-9
A12AT2	19192-001	ATTEN CHIP LOW PWR 4GHZ 9dB	KDI PYROFILM CORP	TCAW-9
A12AT3	19192-002	ATTEN CHIP LOW PWR 4GHZ 20dB	KDI PYROFILM CORP	PCAW-20
A12C1	17094-001	CAP CHIP,CERAMIC 100PF 10%,50V	JOHANSON DIELECTRICS, INC	500R12Q101KV4
A12C2	17094-001	CAP CHIP,CERAMIC 100PF 10%,50V	JOHANSON DIELECTRICS, INC	500R12Q101KV4
A12C3	17094-001	CAP CHIP,CERAMIC 100PF 10%,50V	JOHANSON DIELECTRICS, INC	500R12Q101KV4
A12C4	17094-001	CAP CHIP,CERAMIC 100PF 10%,50V	JOHANSON DIELECTRICS, INC	500R12Q101KV4
A12C5	17094-001	CAP CHIP,CERAMIC 100PF 10%,50V	JOHANSON DIELECTRICS, INC	500R12Q101KV4
A12C6	17094-001	CAP CHIP,CERAMIC 100PF 10%,50V	JOHANSON DIELECTRICS, INC	500R12Q101KV4
A12C7	17094-001	CAP CHIP,CERAMIC 100PF 10%,50V	JOHANSON DIELECTRICS, INC	500R12Q101KV4
A12C8	17094-001	CAP CHIP,CERAMIC 100PF 10%,50V	JOHANSON DIELECTRICS, INC	500R12Q101KV4
A12C10	17094-001	CAP CHIP,CERAMIC 100PF 10%,50V	JOHANSON DIELECTRICS, INC	500R12Q101KV4
A12C11	17094-001	CAP CHIP,CERAMIC 100PF 10%,50V	JOHANSON DIELECTRICS, INC	500R12Q101KV4
A12C12	17094-001	CAP CHIP,CERAMIC 100PF 10%,50V	JOHANSON DIELECTRICS, INC	500R12Q101KV4
A12C13	17094-001	CAP CHIP,CERAMIC 100PF 10%,50V	JOHANSON DIELECTRICS, INC	500R12Q101KV4
A12C14	17094-001	CAP CHIP,CERAMIC 100PF 10%,50V	JOHANSON DIELECTRICS, INC	500R12Q101KV4
A12C16	17094-001	CAP CHIP,CERAMIC 100PF 10%,50V	JOHANSON DIELECTRICS, INC	500R12Q101KV4
A12C17	17094-001	CAP CHIP,CERAMIC 100PF 10%,50V	JOHANSON DIELECTRICS, INC	500R12Q101KV4
A12C18	17094-001	CAP CHIP,CERAMIC 100PF 10%,50V	JOHANSON DIELECTRICS, INC	500R12Q101KV4
A12C19	17094-001	CAP CHIP,CERAMIC 100PF 10%,50V	JOHANSON DIELECTRICS, INC	500R12Q101KV4
A12CR1	13618	DIODE,uWAVE PIN SW,.3PF,100ns	SDI	PER WMI PRINT
A12CR2	13618	DIODE,uWAVE PIN SW,.3PF,100ns	SDI	PER WMI PRINT
A12CR4	13618	DIODE,uWAVE PIN SW,.3PF,100ns	SDI	PER WMI PRINT

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A12CR5	13618	DIODE,uWAVE PIN SW,.3PF,100ns	SDI	PER WMI PRINT
A12CR6	13618	DIODE,uWAVE PIN SW,.3PF,100ns	SDI	PER WMI PRINT
A12CR8	13618	DIODE,uWAVE PIN SW,.3PF,100ns	SDI	PER WMI PRINT
A12CR9	13618	DIODE,uWAVE PIN SW,.3PF,100ns	SDI	PER WMI PRINT
A12CR10	13618	DIODE,uWAVE PIN SW,.3PF,100ns	SDI	PER WMI PRINT
A12CR11	13618	DIODE,uWAVE PIN SW,.3PF,100ns	SDI	PER WMI PRINT
A12CR12	13618	DIODE,uWAVE PIN SW,.3PF,100ns	SDI	PER WMI PRINT
A12FL1	13743	FILTER, EMI, 10 MHZ TO 10 GHZ	ERIE TECHNOLOGICAL	1250-003
A12FL2	13743	FILTER, EMI, 10 MHZ TO 10 GHZ	ERIE TECHNOLOGICAL	1250-003
A12FL3	13743	FILTER, EMI, 10 MHZ TO 10 GHZ	ERIE TECHNOLOGICAL	1250-003
A12FL4	13743	FILTER, EMI, 10 MHZ TO 10 GHZ	ERIE TECHNOLOGICAL	1250-003
A12FL5	13743	FILTER, EMI, 10 MHZ TO 10 GHZ	ERIE TECHNOLOGICAL	1250-003
A12FL6	13743	FILTER, EMI, 10 MHZ TO 10 GHZ	ERIE TECHNOLOGICAL	1250-003
A12FL7	13743	FILTER, EMI, 10 MHZ TO 10 GHZ	ERIE TECHNOLOGICAL	1250-003
A12FL8	13743	FILTER, EMI, 10 MHZ TO 10 GHZ	ERIE TECHNOLOGICAL	1250-003
A12FL9	13743	FILTER, EMI, 10 MHZ TO 10 GHZ	ERIE TECHNOLOGICAL	1250-003
A12FL10	13743	FILTER, EMI, 10 MHZ TO 10 GHZ	ERIE TECHNOLOGICAL	1250-003
A12FL11	13743	FILTER, EMI, 10 MHZ TO 10 GHZ	ERIE TECHNOLOGICAL	1250-003
A12J1	17000	CONN,TYPE N,FEMALE,PANEL MOUNT	M/A-M OMNI SPECTRA, INC	WMI DWG 17000
A12Q1	17093	TRANSISTOR, 2N5108 (NPN)	MOTOROLA (SPD)	2N5108
A12R1	10015-047	RES MET FILM 2.49K OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 2.49K OHM 1%
A12R2	10015-159	RES MET FILM 402 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 402 OHM 1%
A12R3	10015-076	RES MET FILM 30.1 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 30.1 OHM 1%
A12R4	11518-002	RES MET FILM 1.0K OHM 1%	DALE ELECTRONICS	CMF-50 1001 F T-1
A12R7	11518-002	RES MET FILM 1.0K OHM 1%	DALE ELECTRONICS	CMF-50 1001 F T-1
A12R8	11518-007	RES MF 499 OHM 1%,1/8W,100PPM	CORNING GLASS WORKS	CT50-499 OHM 1%
A12R11	11518-002	RES MET FILM 1.0K OHM 1%	DALE ELECTRONICS	CMF-50 1001 F T-1
A12R12	11518-007	RES MF 499 OHM 1%,1/8W,100PPM	CORNING GLASS WORKS	CT50-499 OHM 1%
A12R14	11518-002	RES MET FILM 1.0K OHM 1%	DALE ELECTRONICS	CMF-50 1001 F T-1
A12R15	11518-002	RES MET FILM 1.0K OHM 1%	DALE ELECTRONICS	CMF-50 1001 F T-1
A12R16	11518-007	RES MF 499 OHM 1%,1/8W,100PPM	CORNING GLASS WORKS	CT50-499 OHM 1%
A12R20	11518-002	RES MET FILM 1.0K OHM 1%	DALE ELECTRONICS	CMF-50 1001 F T-1
A12R21	11518-007	RES MF 499 OHM 1%,1/8W,100PPM	CORNING GLASS WORKS	CT50-499 OHM 1%
A12R23	11518-002	RES MET FILM 1.0K OHM 1%	DALE ELECTRONICS	CMF-50 1001 F T-1
A12R24	11518-007	RES MF 499 OHM 1%,1/8W,100PPM	CORNING GLASS WORKS	CT50-499 OHM 1%
A12R30	11518-002	RES MET FILM 1.0K OHM 1%	DALE ELECTRONICS	CMF-50 1001 F T-1
A12R31	11518-002	RES MET FILM 1.0K OHM 1%	DALE ELECTRONICS	CMF-50 1001 F T-1
A12R32	11518-007	RES MF 499 OHM 1%,1/8W,100PPM	CORNING GLASS WORKS	CT50-499 OHM 1%
A12R33	10015-068	RES MET FILM 100 OHM 1% 1/8W	CORNING GLASS WORKS	RN55D 100 OHM 1%
A12RT1	19425-002	THERMISTOR, GLASS BEAD 68K OHM	THERMOMETRICS	BR16PB683K
A12W1	17098	CABLE ASSY, CALIBRATOR 1 GHz	WAVETEK MICROWAVE	WMI DWG 17098

Wavetek Model 8501A/8502A
MANUAL CORRECTION SHEET

This Manual Correction Sheet lists the corrections that must be incorporated into this manual to make it correspond to a particular instrument. The serial number of each instrument (located on the rear panel) is prefixed by a code (configuration reference designation) number. This code number is used to identify the applicable manual corrections required for a specific instrument. When correcting this manual, check first for the code number of the manual (located in small print in the lower right corner of the Title page), and then add all of the corrections shown on this (these) sheet (sheets) for that code number (if any) and all higher numbers up to the code level of the instrument. If a particular component has been changed more than once, make only the highest (code number) change encountered. When the word "ALL" appears, this means that the specified correction pertains to all code numbers of current instruments being described by this latest version of the manual. (Note: "SD" used below means Schematic Diagram)

CODE NUMBER	DESCRIPTION	(ECO NO.)
ALL	On page 8-41, SD 21096 Sheet 3, change R36 (located in the left, center of the SD) from 4.02K to 402K	1945
	On page 8-5, SD 20522 Sheet 2, change A10 (located in the upper left corner of the SD) Assy number from 20274 to 20879.	1946
14	On page 8-5, SD 20522 Sheet 2, change A11 Assy number from 16869 to 20729-001 and A13 Assy Number from 16869 to 20729-002. (Located on right side of the SD)	1962
	On page 9-2, for the 8501A, add under A9 the following: A11 20729-001 Delay Line Assy Wavetek Microwave 20729-001	
	On page 9-2, for the Model 8502A, add before and after A12 the following: A11 20729-001 Delay Line Assy Wavetek Microwave 20729-001 A13 20729-002 Delay Line Assy Wavetek Microwave 20729-002	
	On page 9-17, change A6C66 from current listing (Value & P/N ONLY) to the following: 220PF 15776-013	
	On page 8-33, SD 20742 Sheet 2, change the value of C66 (located on lower left side of SD) from 150 PF to 220 PF	

Wavetek Model 8501A/8502A
MANUAL CORRECTION SHEET

This Manual Correction Sheet lists the corrections that must be incorporated into this manual to make it correspond to a particular instrument. The serial number of each instrument (located on the rear panel) is prefixed by a code configuration reference designation) number. This code number is used to identify the applicable manual corrections equired for a specific instrument. When correcting this manual, check first for the code number of the manual located in small print in the lower right corner of the Title page), and then add all of the corrections shown on this (these) sheet (sheets) for that code number (if any) and all higher numbers up to the code level of the instrument. If a particular component has been changed more than once, make only the highest (code number) change encountered. When the word "ALL" appears, this means that the specified correction pertains to all code numbers of current instruments being described by this latest version of the manual.

CODE NUMBER	DESCRIPTION	(ECO NO.)
ALL	On pages 4-19 and 4-20 the *RISE, *FALL, *PLWD, *RSFL and *RSWD commands should be specified as operable only when the PPM is in the Marker Mode. On page 4-17 the *PUFT, *PURT, and *PUWD commands should be specified as operable only when the PPM is in the Graph Mode. On page 4-19 the RPOA and RPOB commands should be specified as operable only when the PPM is in the Graph Mode.	

Wavetek Model 8501A/8502A
MANUAL CORRECTION SHEET

This Manual Correction Sheet lists the corrections that must be incorporated into this manual to make it correspond to a particular instrument. The serial number of each instrument (located on the rear panel) is prefixed by a code (configuration reference designation) number. This code number is used to identify the applicable manual corrections required for a specific instrument. When correcting this manual, check first for the code number of the manual (located in small print in the lower right corner of the Title page), and then add all of the corrections shown on this (these) sheet (sheets) for that code number (if any) and all higher numbers up to the code level of the instrument. If a particular component has been changed more than once, make only the highest (code number) change encountered. When the word "ALL" appears, this means that the specified correction pertains to all code numbers of current instruments being described by this latest version of the manual. NOTE: "SD" used below means Schematic Diagram.

CODE NUMBER	DESCRIPTION	(ECO NO.)
ALL	On page 8-5, SD 20522, Sheet 2 in the upper left section, change the W4P1 and W4P2 shown on each side of the W8 cable designation to W8P1 and W8P2 respectively. On page 8-3, SD 20522, Sheet 1 in the left center section, change the W4P1 and W4P2 pin connections as shown below.	1976
ALL	On page 9-2 (for the 8501A instrument) and page 9-3 (for the 8502A instrument) change F1 to read "SLO BLO" instead of STANDARD Fuse, and change part number to 15058-001.	1987
15	On page 9-7, change A3C15 from current listing (Value & P/N Only) to: 100 pf 15776-028 On page 9-7, add below A3C56 the following:	2018
A3C57	15776-001 CAP. CER .01 MF 10% 50V CENTRALAB CW15C103K	
	On page 8-19, SD 21015, Sheet 2, change C15 value to 100 pF and show C57, .01 uF, attached across R18.	
ALL	On page 7-7, CPU Board (A4), Step A.3, change the ± tolerance given from ±0.000040 to ±0.000100 µsec. On page 7-8, Digital Delay Board (A5), Step A.3, change the ± tolerance from ±100 Hz to ±1 kHz.	2030

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CODE NUMBER	DESCRIPTION	(ECO NO.)
ALL	On page 7-16, Cal Data Recording Sheet, change the Specification given for the CPU Bd. Step A.3, from current listing to: 30.517478 to 30.517678 µsec On page 1-4, add after the Calibration Factor Uncertainty heading the following: "(at multiples of 1 GHz)" On page 2 of the RF DETECTORS FOR THE MODEL 8501A/8502A METERS Technical Information publication that came with this manual, add after the Calibration Factor Uncertainty heading the following: "(at multiples of 1 GHz)"	
16	On page 9-14, change A5R31, A5R41, and A5R49 (P/N and Value Only) from current listing to: A5R31 P/N 10015-077 1.24K A5R41 P/N 10013-025 1K A5R49 P/N 10013-049 100K	2045
	On page 9-13 below A5C103, add the following: A5C104 10001-003 CAP CER 10PF 5% 1000V SPRAGUE ELECTRIC CO 10TCCQ10	
	On page 9-13 below A5CR2, add the following: A5CR3 10043 DIODE 1N4148/1N914 FAIRCHILD 1N4148	
	On page 8-27, SD 16686 Sheet 2, in the right, center area of the sheet, add: C104 10pF between U37-6 and U37-7, and CR3 1N4148 between U34-2 and U34-3.	

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CODE NUMBER	DESCRIPTION	(ECO NO.)
15A	On page 4-33, add the following ahead of the command "PKAB" at the top of the left hand column: FALL Returns value of fall time, rise time, pulse width and peak power. (This command on the GPIB for Channel A and Channel B returns as a continuous, comma separated, series of values and mnemonics) For Channel A: FALA+0022.9E-09, RISA+0013.0E-09 WIDA+0749.5E-09, PKRA+015.57 For Channel B: FALB+0023.4E-09, RISB+0012.5E-09 WIDB+0748.2E-09, PKRB+015.62	2063

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CODE NUMBER	DESCRIPTION	(ECO NO.)
15A	On page 9-21, change *both* A6U31 and A6U33 (Wavetek and Manufacturer's part number only) from current designation to the following: Wavetek P/N: 21264 Harris P/N: HA3-5002-5 On page 8-33, SD 20742 Sheet 2, change the description of U31 and U33 at the bottom of the SD from HA-5033 TO: HA3-5002-5. On the above SD, add a jumper to both U31 and U33 between pins 1 and 7 (+15V), and pins 2 and 5 (-15V).	2050 A
ALL	On page 9-2. under the Model 8501A parts listing add below Referemce Designation A9 the following:	
A10 20879	EL DISPLAY MODULE ASSEMBLY WAVETEK MICROWAVE	WMI 20879

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CODE NUMBER	DESCRIPTION	(ECO NO.)
ALL	On page 6-4 of the 8501A/8502A manual, under Step 1 of the Delay Accuracy Test, add "1. a) Note Cursor Delay Value". Change Step 2 to read as follows: ""2. Press the MENU key four times (fourth menu) and select F1. Set the "Reference Delay" to be the value read at the 50% point of the first pulse (causing the cursor delay to be zero)."" Delete all of the a) b) and c) sub-steps of Step 2, and specify Step 3 as the last paragraph of the Delay Accuracy Test which starts: "Now set the start delay to 799.90 µs. Set the cursor delay to ----------."	- - - - - -

Wavetek Models 8500A and 8500
MANUAL CORRECTION SHEET

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CODE NUMBER	DESCRIPTION	(ECO NO.)
ALL	On page 8-31 of the 8500A manual or page 8-27 of the 8500 manual, SD 20742 Sheet 1, on the lower left side of the sheet, SAMPLE 1 and $\overline{\text{SAMPLE 1}}$ are reversed. SAMPLE 1 should enter the board on pin 20, and $\overline{\text{SAMPLE 1}}$ should enter the board on pin x.	2080

Giga-tronics Model 8501A/8502A
MANUAL CORRECTION SHEET

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CODE NUMBER	DESCRIPTION	(ECO NO.)
ALL	On page 6-4 of the 8501A/8502A manual, under Step 1 of the Delay Accuracy Test, add "1. a) Note Cursor Delay Value". Change Step 2 to read as follows: "2. Press the MENU key four times (fourth menu) and select F1. Set the "Reference Delay" to be the value read at the 50% point of the first pulse (causing the cursor delay to be zero)." Delete all of the a) b) and c) sub-steps of Step 2, and specify Step 3 as the last paragraph of the Delay Accuracy Test which starts: "Now set the start delay to 799.90 µs. Set the cursor delay to ------------."	------
ALL	On pages 9-2 and 9-3, change F1 (for both 8501A and 8502A respectively) from current listing to the following: 15058-001 FUSE, SLO BLO 2 AMP 250V LITTLEFUSE 313-002	------
16A	On page 8-37, SD 20196 Sheet 1, indicate that pin 14 of U11 (located in the upper, left section of the sheet) is now connected to the +5V supply	2112

CW Power Meters • Peak Power Meters
Precision Scalar Analyzers
Attenuator Calibration Systems • Amplifier Test Systems
Micro Sources • Micro Sweepers

Giga-tronics

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